E. Eng. Lib.
Wahr

INDEX TO 1928 IN 1929 VOL., P. 132-134

THE BLAST FURNACE

Editor—DON N. WATKINS

EDITORIAL ADVISORY BOARD
H. J. Freyn
Barton R. Shover
Dr. J. S. Unger
F. E. Kling

Volume XVI.

CONTENTS for

General Reviews

Iron and Steel Economics in Soviet Russia......... 1
By H. J. FREYN

Blast Furnace Practice in Germany................ 8
By H. A. BRASSERT

Blast Furnace Developments in 1927............... 15
By H. A. BERG

Review of Iron and Steel Literature for 1927....... 20
By E. H. McCLELLAND

Electrification of Rolling Mills in 1927............. 31
By J. D. WRIGHT

The History of the Refractories Industry.......... 38
By J. D. RAMSAY

Metallurgical Development of 1927 46
By STEPHEN GOODALE

Yearly Index to Blast Furnace and Steel Plant, January to December.......................... 59-60

Blast Furnace Department

Iron and Steel Economics in Soviet Russia......... 1
By H. J. FREYN

Blast Furnace Practice in Germany................ 8
By H. A. BRASSERT

Blast Furnace Developments in 1927............... 15
By H. A. BERG

Metallurgical Developments of 1927................ 46
By STEPHEN GOODALE

Progress in the Blast Furnace Field............... 49
By O. R. RICE

The Plants of Pittsburgh Steel Company........... 63

Steel Works Department

Roll Neck Brasses for Sheet and Tin Mills......... 4
By T. J. S.

The Use and Abuse of Chilled Rolls............... 12
By W. H. MELANEY

Notes on Open Hearth Furnaces................... 18
By MARTIN J. CONWAY

Ingot Mold Life and Chemical Analysis............ 29
By E. H. WILLIAMS

Outstanding Open Hearth Improvements.......... 34
By C. W. VEACH

The Open Hearth Furnace in Leash............... 41
By G. A. MERKT

Metallurgical Developments of 1927............... 46
By STEPHEN GOODALE

The Plants of Pittsburgh Steel Company.......... 63

The Steel Plant Brick Mason 79

Safety First in the Steel Plant.................... 82

Rolling Mill Department

Roll Neck Brasses for Sheet and Tin Mills......... 4
By T. J. S.

The Use and Abuse of Chilled Rolls............... 12
By W. H. MELANEY

Electric Drives in the Steel Rolling Mills.......... 24
By A. F. KENYON

Electrification of Rolling Mills in 1927............. 31
By J. D. WRIGHT

The Plants of Pittsburgh Steel Company.......... 63

Published the first of each month by Steel Publications Incorporated
MAIN OFFICE
Thaw Building, 108 Smithfield Street, Pittsburgh, Pa.
President—DON N. WATKINS
Vice President—D. S. WATKINS
Secy. and Treas.—M. M. ZEDER

AND STEEL PLANT

Managing Editor—CHARLES LONGENECKER

EDITORIAL ADVISORY BOARD
Kenneth B. Lewis
E. H. McClelland
D. L. Mathias
F. F. Slick

JANUARY, 1928
Number 1

By-Product Coke Department

The By-Product Coke and Gas Industry 28
By C. J. RAMSBURG

Mechanical Department

Roll Neck Brasses for Sheet and Tin Mills 4
By T. J. S.

Review of Iron and Steel Literature for 1927 20
By E. H. McCLELLAND

Ingot Mold Life and Chemical Analysis 29
By E. H. WILLIAMS

With the Equipment Manufacturers 56

Yearly Index to Blast Furnace and Steel Plant, January to December 59-60

Production Topics

Iron and Steel Economics in Soviet Russia 1
By H. J. FREYN

Metallurgical Developments of 1927 46
By STEPHEN GOODALE

With the Equipment Manufacturers 56

Technical Literature

Review of Iron and Steel Literature for 1927 20
By E. H. McCLELLAND

Yearly Index to Blast Furnace and Steel Plant, January to December 59-60

Power Department

Electric Drives in the Steel Rolling Mills 24
By A. F. KENYON

Electrification of Rolling Mills in 1927 31
By J. D. WRIGHT

Pulverized Coal at Huntley Station 50
By E. J. BILLINGS

Auxiliary Fuel with Blast Furnace Gas 52
By F. H. DANIELS

Power Plants of Pittsburgh Steel Company 74
By W. EDGAR REED

Metallurgical

Iron and Steel Economics in Soviet Russia 1
By H. J. FREYN

Notes on Open Hearth Furnaces 18
By MARTIN J. CONWAY

The By-Product Coke and Gas Industry 28
By C. J. RAMSBURG

Outstanding Open Hearth Improvements 34
By C. W. VEACH

The Open Hearth Furnace in Leash 41
By G. A. MERKT

Metallurgical Developments of 1927 46
By STEPHEN GOODALE

Miscellaneous

With the Equipment Manufacturers 56

Trade Publications 58

Yearly Index to Blast Furnace and Steel Plant, January to December 59-60

News of the Plants 61

Open Hearth .... 62 and 77

Editorial—Prosperity from Within 65

Trade Notes 78

The Steel Plant Brick Mason 79

Safety First in the Steel Plant 82

EASTERN MANAGER
ROBERT E. POWELL
29 West Thirty-fourth Street, New York
Phone—Wisconsin 5459

WESTERN MANAGER
GEO. P. GRANT
105 West Monroe Street, Chicago, Ill.
Phone—Randolph 3264

Subscription Price:—In the United States, $2 per year; Canada, $2.50; all other countries, $3.50. Annual Issue, $1.00.
Entered as second-class mail matter at Pittsburgh, Pa., under the Act of Congress, March 3, 1879.

The Blast Furnace and Steel Plant

Vol. XVI PITTSBURGH, PA., JANUARY, 1928 No. 1

Prosperity From Within

ONCE more the curtain rises upon a stage set with unlimited possibilities; 1928 makes its bow to the world as 1927 waves a gesture of farewell. What 1928 has to offer is largely dependent upon you and upon me. While we are the audience we are also the actors, and upon us rests the responsibility as to whether the play, when the curtain is rung down at the end of a twelfth-month, will have created a feeling of depression or of joyfulness.

Each industry plays its part on the stage of the world's activities and although each is susceptible to influences emanating from others there are certain factors, making for success within a particular industry, which can only be controlled by its directing heads. This is especially true of the steel industry. It can only dispose of its products as a demand arises, but prosperity can be promoted by the judicious management of its operating units.

Thus, by maintaining plant efficiency at a high standard, costs of production can be stabilized, or lowered, with the result that the sale of products may be made more attractive to prospective purchasers; no argument need be advanced to demonstrate the necessity of keeping plant equipment modern and in first-class repair; by adequate research, the quality of commodities is increased and the consumer is thereby enabled to obtain metal better fitted for the intended purpose. This latter feature finds special application in the creation of new alloys as such alloys offer increased physical properties and open up a much wider range of service.

Space does not permit the enumeration of the many other means by which prosperous conditions may be advanced within the industry, but if this year those responsible for the conduct of our plants spare no effort to elevate the standards of operation and service, much will be done to insure a sigh of regret for 1928 when it, like 1927, steps off the stage.

Iron and Steel Economics in Soviet Russia

One Who Is Most Intimately Acquainted with Conditions in Russia Gives Authentic Information in Regard to the Rehabilitation of the Steel Industry in That Country

By H. T. FREYN*

BEFORE the World War the iron and steel industry of Russia was indirectly, though effectively controlled by foreign capital. While nominally Russian, the steel companies were in Belgian, French, German and English hands through syndicated banking interests, and the management was substantially in charge of foreigners.

In 1913 the total population of Imperial Russia, inclusive of territory subsequently detached from the former empire, was around 182,000,000.

The pig iron production at that time was 4,150,000 gross tons; imports of 30,000 tons brought the total consumption to less than 4,200,000 tons, corresponding to a little over 51 lb. per capita. Steel ingot production was 4,180,000 gross tons, or not quite 52 lb. per capita.

The section of Poland and the border states to the northeast, which previously formed part of the body economic of Russia, had been, industrially, the most developed provinces. That the iron and steel consumption of that immense country was no higher in 1913 than that of the United States before the Civil War, was due not so much to the pre-eminently agricultural nature, but to the generally low cultural level of a polyglot population maintained for centuries in ignorance and virtual serfdom under an absolute and reactionary government. A high tariff permitted the foreign controlling interests to maintain high prices on a curtailed output in the home markets, and to reap large profits from an industry supported by abundant cheap raw materials and low-priced labor.

These conditions not only stultified the healthy growth and progressive development of this basic industry, but promoted a laissez-faire policy, as a result of which many plants are in operation today which should have been razed or rebuilt 25 or 30 years ago.

H. T. FREYN
President, Freyn Engineering Company

Feverish Activity During War

During the World War, when iron and steel was at a premium, frantic efforts were made to construct additional capacity, particularly in the Ural and in the South where the principal iron ore and coal deposits occur. Every existing plant was worked to capacity and little thought could be given to much-needed repairs, let alone improvements. Every pound of iron and steel produced in the entire realm was devoted to war requirements and nothing was left to satisfy the demands of agriculture and peace-time industry. The catastrophic social and economic upheaval of the Revolution, the subsequent civil wars and foreign invasions completed what the World War had begun—an absolute exhaustion of existing stocks and the virtual annihilation of production. At the time of the revival in Russia inaugurated by the New Economic Policy in 1921, there was almost literally neither pot nor pan in the possession of the Russian people. This situation is best illustrated by the annual production figures, bearing in mind that imports were practically nil. In the year 1917, pig iron production had dropped to 2,970,000, and steel ingots to a little over 3,000,000 gross tons, or 72 per cent of pre-war figures. Then a precipitate decline set in, so that in 1918 pig iron production was only about 12 per cent and steel ingot production but 9½ per cent of prewar. During 1919, 1920 and 1921 there was an average of only 113,000 tons of pig iron made, corresponding to the annual production of one single 300-ton blast furnace, and resulting in a decline to 2¾ per cent of the 1913 figure. Steel ingot production averaged in these three years 193,000 tons, or 4½ per cent of prewar. The annual per capita pig iron consumption had dropped almost out of sight, amounting to less than 2 lbs.

War and revolution had sapped the country's resources in capital and man power. With few exceptions, the plants were damaged, destroyed, pilfered and abandoned.

---

*President, Freyn Engineering Company.

Technical and operating forces had disappeared, decimated by war, terror, famine, exile and flight. Such was the condition in 1920 and 1921.

New Economic Policy

With the advent of the New Economic Policy, Russia resumed work. Economic life revived slowly. Production in the iron and steel industry increased gradually. Plants that had been idle or abandoned for years were overhauled and started. Furnaces were lit and wheels began to turn. Much work and considerable expenditure were required to repair the damage wrought by years of idleness and neglect. Deferred maintenance took a heavy toll. Russian engineers, technicians and workmen had to be brought back because the former foreign managers and engineers refused to return. Labor was inefficient, management inexperienced and costs were high. There was no working capital and no credit. Mines were idle and the transportation system disorganized and broken down. There was lack of everything. While discussing the situation in 1921 with some foreign refugees, formerly executives of Russian steel plants, they insisted that it was just as futile to attempt starting the Russian iron and steel industry in operation as it was impossible to build and operate a blast furnace on a desert island. Nevertheless, at the end of the fiscal year 1921-22 pig iron production had risen to 170,000 and steel ingot production to 310,000 gross tons. They increased to 300,000, or 7 per cent, and 600,000 tons, or 14 per cent, of the prewar figures during 1922-23. In the following year (1923-24) pig iron production more than doubled (650,000 tons), reaching 15.7 per cent of the prewar output, while ingot production rose to 980,000 tons, an increase of 63 per cent in that year. The per capita production of pig iron was then 10 lb. The fiscal year 1924-25 brought another virtual doubling of pig iron and steel ingot production to 1,270,000 tons and 1,840,000 tons, respectively, and with a population of 139,500,000, per capita production had climbed to 20 lb. of pig iron and 30 lb. of steel. This rapid recovery was maintained, although at a diminishing rate, during the ensuing two years. In 1925-26 pig iron production was 2,180,000 tons, or 52.5 per cent of prewar, while the corresponding figures for steel ingots were 2,870,000 tons and 69 per cent. The fiscal year 1926-27, terminating September 30, showed an increase to 2,920,000 tons of pig iron and 3,490,000 tons of steel ingots. The iron and steel industry of the Soviet Union, with 71 per cent pig iron and 84 per cent ingot production, is now the only large industry which has not yet reached the prewar level. With a population estimated at 149,600,000 as of January 1, 1928 (82 per cent of prewar), the per capita consumption, owing to imports of some 75,000 tons of iron and steel, is now somewhat more than 44 lb. of pig iron and 52 lb. of steel. The significant fact is that since the minimum production in 1920-21, there has been in seven years the phenomenal total recovery of nearly 2,600 per cent, or an average of about 172 per cent per year.

But even when considering only the half decade, 1922-23 to 1926-27, which is more characteristic of the working of the New Economic Policy and of reorganization of the industry, the increase of nearly 1000 per cent, or an annual average of better than 177 per cent, is remarkable.

Iron and Steel Industry Budgetted

The iron and steel industry—as are all other basic industries in the Soviet Union—is being "budgetted" both as to production and capital expenditures over five-year periods. The estimate for the five-year period beginning October 1, 1927, shows iron and steel requirements of the Soviet Union of about 26,500,000 gross tons in round figures. This total includes such items as 3,300,000 tons rails, 2,200,000 tons sheet steel, 7,900,000 tons structural shapes, 1,650,000 tons wire, over 5,000,000 tons foundry iron, etc. Pig iron production during the same period will increase by 90 per cent over the corresponding figure for the year just ended; while ingot production will be 69 per cent greater. Nevertheless, it is not expected that the demand will be satisfied. It is estimated that the supply by Soviet Union metallurgical plants will cover only 83.9 per cent of the demand in 1927-28, reaching 90.2 per cent in 1931-32. The average over the next five years is but 87.6 per cent. The percentage of coverage will, however, be only 61.6 per cent for tubular goods and 70.8 per cent for rails. The demand for pig iron is expected to be covered to the extent of 95 per cent by 1931-32. It is interesting to note how the demand figures for iron and steel were arrived at. The work of preparing the estimate required two years and over one thousand people were engaged on it. Estimates were made by competent persons in the various agricultural, industrial and manufacturing sections and principal consuming centers of all Soviet republics. This information was collected, assembled and checked by a committee of some 20 economists and specialists. The financial budget apportioned to the iron and steel industry over the five-year period determined the scope of the possible reconstruction and new construction of productive capacity. The figures given before, taken from the official program, prepared by the Supreme Economic Council of the Soviet Union, are the result of this budget plan. From this information it is evident that for years to come the Soviet iron and steel industry will be confronted by the problem of meeting the domestic demand. It must be borne in mind, moreover, that the visible or estimated demand will in all probability be measurably exceeded by the actual consumption in a country where industrialization is being pressed with so much determination and vigor as in the Soviet Union. At any rate, allowing a 5 per cent increase in population by the end of the fiscal year 1931-32, the per capita production of pig iron will be less than 80 lb. This is approximately 10 per cent of the per capita consumption in the United States at the present time, and only 11½ per cent of our average for the last decade. With more widespread education, intensive industrialization, rationalization of agriculture and manufacture and the general raising of the cultural level of the Russian population, it is difficult to see how the Soviet Union can for decades to come give any thought to competition with any foreign nation in the world's iron and steel markets. Russia is at present devoting her energies to an extent unparalleled in the history of the country to the construction of new plants, to the building of new railroads, bridges, roads, ships, houses, power plants, and to the manufacture of agricultural implements and other machinery, which means an ever increasing demand for iron and steel that cannot be supplied by the domestic industry.

Resources of Russia

The past performance and the expected development of the iron and steel industry of the Soviet Union are based on the enormous natural resources of that country. It is interesting to note that the explored iron ore resources of the Soviet Union are surpassed only by those of France, the United States and Canada. The Fe content of the available ore in the Soviet Union is estimated at 1,100,000,000 tons. Since her resources have been comparatively but little explored, this figure by no means includes all iron ore resources of the country. The magnetic anomaly in the Kursk region seems to indicate the presence in that region of enormous iron ore resources, provisionally estimated as amounting to tens of billions of tons. The Soviet Union coal resources are estimated at 465,000,000,000 tons.

The increase in production of iron and steel in Soviet Russia during the last few years was accomplished by considerable investments. The allotment for the iron and steel industry in the fiscal year 1927-28 is about 150,000,000 rubles, or over $75,000,000. This money will be applied for the reconstruction and for new equipment of existing steel plants, as well as for the initial financing of certain new steel plants to be built. The budget for the next five-year period contemplates the expenditure in the iron and steel industry on the order of 700,000,000 rubles, or over $350,000,000.

The program of the Supreme Economic Council for the next five years calls for the beginning of work on several large iron and steel plants. Among these is the Kuznetzk metallurgical plant in Siberia, based upon the enormous coal and iron deposits of the Kuznetzk Basin. Its initial production will be about 330,000 tons of pig iron per year, but it is being projected for a subsequent increase of 660,000 tons. At first the entire pig iron production will be used for conversion into steel, the ingot capacity to be about 400,000 tons. The rolled products will consist of rails and heavy girders, track material, billets and sheets. With enlargement of the plant in the future, part of the pig iron production will be utilized for the production of about 50,000 tons of cast iron pipes annually; billet production will be doubled and a plate mill added. Construction was begun in 1927 and the ultimate plant to be completed in 1934.

There is further the Magnetogorsk metallurgical plant in the Ural Mountains, the annual output of which will be about 650,000 tons of pig iron and nearly 600,000 tons of rails and shapes. Plant construction will begin in 1928-29 and the plant is expected to be completed in 1932-33.

General plans for these two plants are now being prepared by Freyn Engineering Company.

Plants to Be Built

In the southern iron ore and coal district in the Ukraine, there will be built a new metallurgical plant at Krivojrog, of an annual capacity of 650,000 tons of pig iron and 250,000 tons of rolled products. Construction of this plant is to begin in 1928 and it will be completed in 1933.

A fourth new metallurgical plant of an output of 325,000 tons of pig iron and 225,000 tons of rolled products, will be completed by 1929 at Kertch, Crimea.

In addition, the construction and reconstruction of other large metallurgical plants is to be undertaken during the next five years, which are referred to as the Far Eastern, Dnieper, Providence, Makeevka and Kadiev plants.

Extensive modernization of the older existing plants is now being undertaken or planned in the near future.

The total number of workmen employed in the Soviet Union iron and steel industry during the past year was 167,900. In view of the proposed expansion of the industry, this number is expected to increase to 203,800, or 21.5 per cent, by 1931-32. The total output of the industry during this period is expected to increase about 80 per cent. Hence the output per man will show considerable gain.

The average monthly wages of workers in the iron and steel industry during the past year were 59 rubles, about $30, an increase of 12 per cent over the preceding year. The wages of iron and steel workers in the Soviet Union compare favorably with prewar wages.

Since the increase in the number of workmen and the gain in wages will be smaller than the increase in production, costs in the iron and steel industry are expected to show a gradual decline. During the year 1927-28, costs are expected to decline 2.6 per cent compared with the fiscal year just closed, and about 5 per cent compared with 1925-26.

A Review of the Electrical Business of 1927

By E. M. Herr*

The year just closing has been a good year for certain industries, but a poor one for others. The automobile industry is an outstanding example of the first; the railway industry of the second.

The railroads have completed another successful year, and have taken advantage of it to still further improve their already good record of efficiency. But unfortunately, the restrictive laws which limit and sometimes prevent the carrying out of beneficial broad executive policies by the railroads have not been modified, so that no relief has been afforded them by this means.

Steady Growth in Industrial Field

The application of electric motors to all kinds of industrial needs has shown progress, and has already reached very large dimensions. As this use is becoming almost universal, progress in this field should continue at a rapid rate.

Motors are, more and more, being designed to meet special conditions. Because of this, more satisfactory motor applications are being made, which so greatly increase the efficiency of the tool or machine to which the motor is applied that large numbers are required to meet the demand, bringing in a volume of business to the motor manufacturer which permits of mass production and often results in a substantial reduction in costs.

Increasing use of electricity for all kinds of industrial heating is indicated. The success of this application of electrical energy insures its steady growth.

Railroad Electrification Prospects Favorable

Progress in the electrification of our railroads has been very much slower than was anticipated some months ago. A considerable increase in the volume of this business in the near future is looked for. It has been demonstrated by existing electrification projects that not only is the comfort of the passengers increased but the capacity of the road, both for passenger and freight traffic, greatly enlarged by this source of power. On roads of dense traffic this is a very compelling reason for electrification.

---

*President, Westinghouse Electric & Mfg. Company.

Roll Neck Brasses for Sheet and Tin Mills

An Engineer Who Has Had Many Years of Experience Relates the Procedure in Making a Study of the Service Given by Brasses of Varying Composition—Results Tabulated

By T. J. S.

WE had already started to collect data for the study of our brass consumption. We intended to determine, if possible, what service should be expected from bearings in certain positions in the mills and thus set a standard with which we could compare the average service of the brasses furnished us by the different foundries on any one or any number of orders for brasses. Our aim was to find out (always if possible) who made the best brasses, whether cast-to-size bearings give better results than machined bearings, what mixes proved best, etc. A large project! It was also strongly recommended to us at this time by experienced makers of brass, that we should use virgin metals for "hot mill" bearings. The original cost would be higher, they said, but the longer service of the brasses would reduce the ultimate cost, which was of course, our real object. However, inquiry among other foundry-men developed the fact that there was a great diversity of opinion among them. One experienced maker of brasses advocated virgin metal only, for these mills; another advised recast metals but of known chemical analysis; while still another would make brasses from virgin metals if specified, but he advised that we use recast metals even though in practice he did not analyze his materials. A consulting engineer of long experience recommended virgin metals, but said that we would have to depend upon the integrity of the maker to supply virgin metals when specified, and so on.

In the end, each man seemed to have his own opinion and none seemed to have first hand information on the subject, but based his statements, if he based them at all, upon the practice of some corporation for which he had made brasses, or upon some vague tests of which he had seen or heard the report although he had not known anything about the conditions of the tests or the manner in which the data had been collected.

Noted American authorities on scientific research recommend the use of either virgin metals or of recast metals of known analysis. We could, of course, have taken this rule as law and ordered our bearings accordingly, but we had, in our general scheme of collecting data, an excellent opportunity of verifying this recommendation under actual mill conditions, and so we included it in our studies. We hope that our results in general, and in this minor detail in particular, together with a description of our plan of collecting data, will be of interest to the reader. And we feel that it will be of especial interest to the man who is doubtful of the service he is getting from his bearings and desires to establish a check or standard length of service.

Outline of Study

Because of its importance, and also in order to give the reader an idea of the pains taken to assure correct reports, it may be best to outline the scheme of this collection and the reasons for adopting the different steps in it.

First, it was realized that all this work must be done accurately if we were to do justice to the producers of our bearings or establish true standards for ourselves. We were not allowed to increase our force and would therefore have to rely upon our workmen in the mills to make correct reports. We feel that we have been successful in obtaining these correct reports and largely because we had previously seen at least two other such systems fail when it was attempted to get accurate data from the regular crew of workmen. There was profit for us in their mistakes. And there may be, in our plan, a profit for the reader who wishes to establish true standards for comparison. Our standards obtained, and shown below, may be true for our mills only, but may be useful in comparing service of brasses in other similar mills.

The first step toward organization was made in securing the solid backing of the official in charge of operations. And this is the most important step of all, for, without the firm demand for results given by the highest official, the whole scheme must fail. And in emphasizing this statement, it is telling no secret to say that studies of this kind are generally considered, in the operating department, to be a sort of nuisance even by the superintendents for whom the work is done and whose costs will be benefited. And the farther we go down the line of operators the less welcome the work seems to be; for the tonnage man is usually intent on getting his orders through and he usually chafes at any interruption. (And if we would confess the truth, we would say that, if we were in his place, we would try to steer clear of them too.) At first we found the rollers lax in their co-operation and some of their records got "lost," but after it was explained to them that their reports would probably mean better bearings, fewer interruptions in their schedule and lower costs to the mill, most of them gave willing help. At the same time, word, which passed down from above that this work was, in fact, part of their jobs, brought the others into line.

Now the organization of the workers in the sheet, tin and blooming mills fitted into our scheme better than did that at the strip mills. In the former, the brasses were put into and taken out of the mill by the millwright who is, of course, primarily a mechanic. He is interested first of all in the upkeep of the material of the mill. He has taken out many brasses and studied them over and has, no doubt, secretly wished that some one would keep a record of them so that he might get better service out of them. It was therefore easy to get his co-operation. He made his reports directly to the master mechanic whose clerk added the hours of service and passed them on to the man whose duty it was to compile the data and make the study. We call him the "study-man."

Strip Mills

In the strip mills, however, we found an entirely different situation, because there the brasses were changed by the operating man—the roller—who, as spoken of above, is always in a hurry "to get her going again," and more interested in maintaining the gage than in looking over "dead" brasses. Furthermore his earnings depend on the tons he rolls. We finally hit upon the plan of requiring him to furnish the serial numbers, and points where they were used, to his recorder who was supplied with proper blanks and reported to the study man. In order that there might be no alibi, the recorder was required to report for each turn, no matter whether brasses were changed or not. This plan worked very well after we had showed the rollers how to lay the worn brasses on the floor at a distance from the mill, but opposite the stand from which they had been taken and in such a way as to indicate the position which they had occupied in the stand. Then he could have the serial numbers cleaned off while the recorder took them down on the blank form. This was a minor detail, but helped immensely toward accuracy.

The reports coming to the study-man from the mills were designed to show, as nearly as it was possible to get the information, all of the data which would be influenced by the service of the bearing. Those from the sheet and tin mills showed the serial number, the date in or out, the location where used in the mill—that is, in top lead, top drag, bottom lead or bottom drag—the number of the mill, the thickness from bore to back when taken out, the number of hours it had been in service, whether worn out or broken, or other cause of removal and whether the brass was scrapped or put into stock.

The reports from the strip mills showed all of the above data except the hours of service, which were arrived at in the following manner. The chief clerk at the strip mill reported to the study-man, at the end of each month, the actual hours run at each mill during each day of that month. By adding each day's net run to the sum of all previous days and setting that figure opposite that particular date on the calendar, we obtained the "key" number for that date. It was then only necessary to subtract this "key" number opposite the date when a brass went into service from the "key" number opposite the date when it came out of service, to obtain the total hours of service of that brass, no matter how long it had been working. We found this to be quite a short-cut.

As for the records which the study-man kept—he started with the requisition for the brasses. All these requistions were passed through his hands and he made note of the brasses which he was studying, on cards that were headed by the pattern numbers. It had already been arranged with the storekeeper that the brasses of these particular patterns should be stamped with serial numbers when received at the store-room, and the study-man notified of the serial numbers given them together with the requisition or order number on which they had been received. This information was noted on the cards; also in a book or binder which contained the serial numbers in numerical order; and everything was then ready to receive data from the field. A typical page from this book, partially filled in with data, is shown in Table A.

TABLE A—BRASSES—HOURS IN SERVICE

Maker and Order No.	Pattern No.	Serial No.	Date In	Date Out	Hours	Location in Mill	Thickness	Worn Out	Broken	Scrapped	Stocked	Remarks
Neilson Co	P.D. 737-A	1547	11- 1-26	1- 7-27	1210	10 B.D.	7/8 in	X	X	X		Bt. Neck
YO-669	P.D. 737-A	8	12-24-26	8- 2-27	3622	2 B L.	1/4 in.	X		X		
YO-669	P.D. 737-A	9	1- 2-27	5- 3-27	2514	5 T.D.					5-3	
YO-669	P.D. 737-A	9	6-13-27	7-18 27	521	4 T L.	3/4 in.		X	7-18		
YO-669	P.D. 737-A	1550	8-14-27			5 T.D.						
Belden YO-672...	C.E. 1520-C	1	8-14-27			6 B.L.						
Belden YO-672....	C.E. 1520-C	2	8-24-27			15 T L.						
Belden YO-672....	C.E. 1520-C	3	11- 6-26	2- 2-27		14 B.D.					2-2	
Belden YO-672....	C.E. 1520-C	3	6-25-27			11 T D.						
Jenkins YO-670 ..	E.L. 221-E	4										
Jenkins YO-670 ..	E.L. 221-E	5										
Jenkins YO-670 ..	E.L. 221-E	6										
Jenkins YO-670 ..	E.L. 221-E	7										
Jenkins YO-670 ..	E.L. 221-E	8										

As a check on the reports from the field, and in order that he may know at all times just what serial numbers are working in the mill, and thus avoid confusion, the study-man kept a second book or binder. A typical page of this is also shown in Table B, and we believe is self explanatory. It will correct most of the errors in the reports and the knowledge among the men that we had a good check on them was a strong factor in securing reliable reports. We jokingly referred to this book as "Our Philadelphia Lawyer."

When we study brasses we must also study the scrap box. The scrap in the scrap box will tell us where the wear comes on the surfaces, whether they are being scrapped too soon, or not soon enough, whether the necks of the rolls have been properly lubricated, where metal should be added to secure greater wear or subtracted to save material. In fact, it could well be the starting place for any new design of the brass.

Virgin and Re-Cast Metals

But let us return to our principle object of establishing a standard length of service for bearings and to the minor object of comparing brasses made from

TABLE B—BRASSES—HOURS IN SERVICE

Mill—Sheet and Tin No. 7.
Stand ....

SERIAL No.	TOP LEAD			TOP DRAG			BOTTOM LEAD			BOTTOM DRAG			PATTERN No.	MAKER	REMARKS
	In.	Out.	Hrs.	In.	Out.	Hrs.	In.	Out.	Hrs.	In.	Out.	Hrs.			
1457........	..	..	......	3—4—27	6—2—27	1540	..	..	......	..	..	......	P.D. 1522-A	Tilden	Scrap
1492........	11—11—26	2—2—27	632	..	..	......	..	..	......	..	..	......	P.D. 1522-A	Tilden	Scrap
1565........	..	..	......	6—2	7—3	326+	3—17	6—1	1120+	..	..	......	P.D. 2024-B	Jenks	Stocked, 6/1 Scrap, 7/3
1576........	..	..	......	..	..	......	..	..	......	2—2—27	6—20—	1800	P.D. 2024-B	Jenks	
1543........	..	..	......	7—3	..	......	.	..	......	..	..	......	P.D. 1522-A	Tilden	
1607........	2—2	..	......	..	..	......	..	..	......	..	..	......	P.D. 1522-A	Tilden	
1620........	..	..	......	.. ..	.. ..	....	6—1	..	......	..	..	......	P.D. 2024-B	Jenks	
1598........	..	..	......	..	..	......	..	..	......	6—20	..	......	P.D. 2024-B	Neil	

virgin metals with those made from re-cast metals. We made a study of roll neck bearings Pat. No. 473-A. This bearing was of the form which has become almost standard in the hot mills of this country, with heavy flange on one end and long body. This particular brass is known in our mill as 2 in. x 13 in., meaning 2 in. thick from bore to back and 13 in. wide over the body. It was chosen for this study because it is used in all four positions in the mill; that is, in top lead, top drag, bottom lead and bottom drag. We also had more of these in use than any other.

The usual method of tabulating reports in the steel business is to reduce all figures to a per ton basis. However, since the sheet mills turn out a heavier tonnage than the tin mills do, we believed the net hours run to be a fairer gage of the quality of the brasses than the tons rolled would be. We therefore showed our figures in actual net hours run.

We show in Tables I and II a comparison of the hours of service of the above mentioned brasses as made by three different manufacturers.

All of the brasses studied here which were made by manufacturers B. & C. were claimed by the makers to have been made from virgin metals and we paid the usual high price for them. On the other hand, the brasses made by manufacturer A, were made from re-cast metals of known analysis. That is, an ingot from each heat of these re-cast metals was submitted to chemical analysis and only such metal was used as came within the specifications required for our castings.

Whether or not we actually receive brasses made from virgin metal, when such are specified, is largely dependent upon the integrity of the foundryman. But by keeping a record of these brasses, we can know whether we receive an increased length of service from them commensurate with the increased price which we pay for them. This is what we attempt to show below.

Where we have had a reasonable doubt of the record of any brass, we have discarded it. Therefore all brasses included in our study are those of which we have clear and full record of their service. This includes all brasses cracked or broken in the ordinary wear and shock of the mills, but does not include those brasses which are reported "burnt" or "broken by broken roll" or which are scrapped when the cause can be traced to similar accidents or bad practice by the operating department.

Of course, when a brass is burnt it is practically impossible to know whether lack of lubrication caused the heating of the brass and a consequent breaking, or whether the weakness of the brass caused it to break, wipe off the lubricant and then heat up the neck. The effect is the same, yet the cause may be different. We have therefore excluded from our study such brasses as are reported "burnt."

Study of Tables

Referring to Table I—it shows:

(A) The number of brasses considered. They were made by the different manufacturers and used as the top or bottom bearing in the mills as shown.

(B) The average hours of service of the above brasses.

These have been divided under the different groups of sheet and tin mills for comparison.

The last two lines are of course a summary of the figures above.

TABLE I—HOURS IN SERVICE
Pattern No. 473-A

	M'F'R. A.			M'F'R. B.			M'F'R. C.		
	Top	Bot.	T.&B.	Top	Bot.	T.&B.	Top	Bot.	T.&B.
Tin Mills, No. 1 to No. 8									
No. Brasses....	3	2	5	....	17	.....	5	4	9
Average Hours.	2346	2632	2461	....	2948	.....	2478	3264	2827
Tin Mills, No. 9 to No. 17									
No. Brasses....	5	13	18	....	2	.....	5	5	10
Average Hours.	3770	2544	2885	....	3008	.....	2502	2581	2541
Sheet Mills, No. 18 to No. 28									
No. Brasses....	23	10	33	14	7	21	9	8	17
Average Hours.	1938	2455	2095	1983	3295	2420	1903	3657	2728
All Mills,									
No. Brasses....	31	25	56	14	26	40	19	17	36
Average Hours.	2273	2515	2381	1983	3046	2674	2212	3247	2701

TABLE II—HOURS IN SERVICE
Pattern No. 473-A

		Top Positions.	Bottom Positions.	Top and Bottom Positions.
Tin Mills, No. 1 to 8	No. Brasses ...	8	23	31
	Average Hours.	2428	2976	2834
Tin Mills, No. 9 to 17	No. Brasses ...	10	20	20
	Average Hours.	3136	2600	2778
Sheet Mills, No. 18 to 28	No. Brasses ...	46	25	71
	Average Hours.	1945	3075	2343
All Mills, No. 1 to 28	No. Brasses ...	64	68	132
	Average Hours.	2192	2901	2557

Table II shows these figures consolidated under head of the two positions where use, and regardless of manufacturer. The third column is a sum of the other two.

The last two lines again are the sums of the ones above, and the last line shows the average hours in service of all brasses in top positions in all mills and all positions in all mills. We believe that these figures represent the approximate average life which may be expected from brasses of this pattern used in the positions shown. That is, about 2,200 hours for the top positions, 2,900 hours for the bottom positions and a general average of 2,550 hours.

It would also seem from Table II that longer service should be expected in the tin mills than in the sheet mills. The fact that the tons rolled on tin mills is only about three-fourths that rolled on sheet mills, may have some bearing on this.

Therefore, when the services of individual brasses or a small group of brasses, such as those received on one order, are compared with the above general figures, it should be borne in mind where these particular brasses have been used—whether in top or bottom position and whether in sheet or tin mills.

From our studies, there seems to be no appreciable difference between the life of brasses used in lead or drag side whether in top or bottom. We have therefore not shown figures for these positions separated in these tables. A difference, however, as is commonly expected, between the hours in the top and bottom positions is clearly shown in the tables. This is in spite of the fact that beside the hours of service here shown, the bottom brasses perform some service while their mills are running idle. But this is more than made up by the fact that they rest solidly in a solid housing thus bringing their full surface to bear at all times, whereas the upper brasses are set in a rider which is free to move sidewise or tilt slightly, thus bringing great bearing pressure on small areas of the brasses at either end or either side of the bore. More rapid wear is the consequence. Lubrication is also no doubt better on the bottom brasses than on the top ones.

Referring to Table III, the top line is taken from the bottom line of Table I and shows the average length of life of all the brasses made by the three different manufacturers. The second line shows their comparative standing in per cent.

TABLE III

	Manufact'r A.	Manufact'r B.	Manufact'r C.
Average Hours......	2381	2674	2701
Per cent (Hours)...	88.1%	99.0%	100%
Adjusted cost per lb. Brass	21.77ct.	24.40ct.	24.77ct.
Per cent (cost per lb. of Brass).........	87.9%	98.5%	100%

Prices

The prices of brass castings are based on the price of Lake copper which varies from month to month. It would therefore be unfair to compare prices of one manufacturer whose brasses were delivered during a month of low base price with those of another whose brasses were delivered during a month of high base price. We have therefore corrected the prices of all manufacturers to correspond with a base of 14 cents Lake copper and such adjusted price is shown in the third line of this table. This is for rough castings only. Line four shows the relation of these prices in per cents. These percentages of costs should be compared with line two above showing the percentages of hours of service. They are very closely in line, with a little advantage in price to the brasses giving the shorter service. This however, we believe will be more than offset by the longer continuous action of the mills due to fewer changes of the longer lived brasses. These long lived brasses were claimed by the makers to be made of virgin metal.

Some of the brasses in this study were cast to size, some were machined on backs only, while others were machined on backs and in the bore. Our studies (not shown here), indicate about the same length of life for all of the above three kinds of bearings, and they will therefore not affect the figures in the tables.

Our studies also show that the breaking of rolls does not affect the consumption of brass to any great number, for, out of 202 bearings among the brasses here studied, only eight were scrapped on account of broken rolls. Nor does the operating practice which results in high or low roll breakage seem to bear any definite relation to the number of brasses used.

Our reports also show the final thicknesses of most of the brasses included in this study and whether they

(Continued on page 11)

Blast Furnace Practice in Germany

One of Our Foremost Engineers Presents Interesting Information Concerning Features Which Have Greatly Increased Furnace Output—Methods May be Applied Here

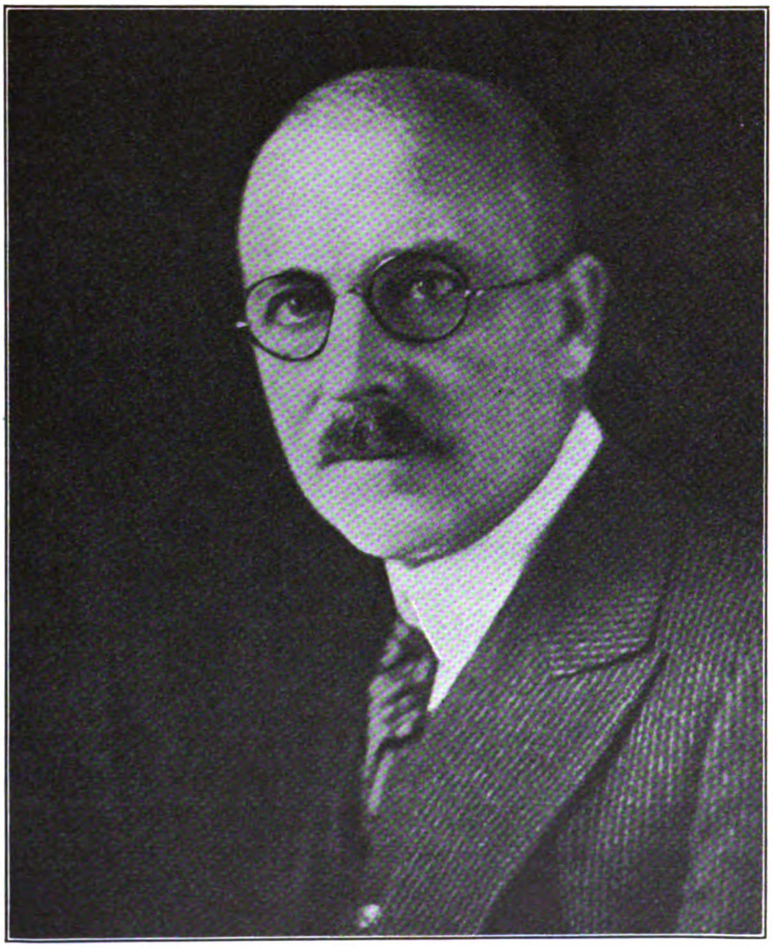
By H. A. BRASSERT*

MUCH has been said about the superior practice of German iron and steel plants in regard to fuel economy. Without question we can learn a great deal from them in this respect and particularly in the economical and more complete utilization of blast furnace gas. A creditable achievement, for instance, is the development and general use of a gas washing plant embodying the disintegrator type of wet washer, which can be designed and operated for practically any desired degree of cleanliness permitting of greater economy in water and power. While it appears as though they have, in some instances, spent money unwisely in trying to save the last heat unit and have sometimes spoiled the arrangement of their plant units in the endeavor to gain the limit of heat conservation, it is certain that their steel industry would not have been able to survive except for their advanced practice in the use of fuel.

Capacity of German Furnaces Increased

But another interesting development has taken place since the war which has been of great economical importance to the German iron and steel industry and which it seems should be applicable to the future development of American blast furnace production. I am speaking of the recent very large increase in the production of the German blast furnaces. At a number of their plants the capacity per stack has been increased 50 per cent and at some as much as 100 per cent compared to pre-war practice, and this has been accomplished with a relatively small investment in plant.

There was a powerful incentive for this German achievement, in fact, Germany was forced to it by the results of the war. She had lost her iron and steel production in Lorraine, as well as giving up her interest in that of Luxembourg, in which district she had built a number of modern plants during the period preceding the war in order to efficiently utilize her share of the Minette ores. These ores were considered too lean (containing only about 30 per cent iron) to transport to the blast furnaces in the Ruhr district; it was more economical to carry the Ruhr coke to Lorraine and Luxembourg. The foundation of the German steel industry had been laid generations earlier in the Rhine, Ruhr and tributary valleys, in the Rhine province and Westphalia, and was based on the great Ruhr coal formations and on local ore deposits. With the gradual exhaustion of these scattered ore bodies, the German blast furnaces in this district were compelled to rely more and more on foreign ores, chiefly those from Sweden and Spain; with the development of the ore bodies of northern Africa, Newfoundland and other foreign markets, all of the world's ore could soon be found assembled in the yards of German furnaces. The Minette ore from Lorraine was used in relatively small proportions, principally to make up the deficiency in phosphorus content of the burden needed for the basic Bessemer process; with the rapid increase in open hearth production less of these lean ores was required and the iron content prior to the war of the average burden in the Ruhr district was well above 50 per cent, eliminating the flux. Therefore, the larger German furnaces using foreign ores were even before the war able to produce up to 500 tons per day, whereas the Lorraine furnaces with their lean ores generally did not average better than 300 tons. The largest German stacks corresponded in cubical content to the larger furnaces in this country at that time, except as to the hearth dimensions, in which respect they were much smaller.



H. A. BRASSERT
President, H. A. Brassert & Company

Furnace Lines Changed

With the loss after the war of the Lorraine and Luxembourg works with an annual capacity of over six million tons of iron—not to mention their losses in Silesia and in the Saar valley—the Germans were confronted with the alternative of confining themselves to approximately 60 per cent of their pre-war production or increasing their pig iron production in the Ruhr district. The latter could be accomplished by building additional blast furnaces or by raising the output of their existing stacks. During my visits in 1920 and again in 1924 I found much interest at German plants in the possibility of introducing our modern practice of larger hearths and lower, steeper boshes, a development which had so greatly increased the production of our American furnaces and which is always more economical than adding new units. On my visit this year I found that the hearth diameters had been increased at many plants although, with the exception of a few furnaces, not to the extent that we had demonstrated as practical in this country. One furnace had been built, as an experiment, with a cylindrical or straight bosh to demonstrate the practicability of eliminating the bosh angle entirely, and another one, the largest constructed anywhere up to that time, was producing consistently 1000 tons per day. However, but few additional new furnaces had been built and yet the total demonstrated capacity had been raised to such an extent as to almost offset that lost through the war. This enormous increase in production was gained through the greatly increased output of relatively small furnaces, the total cubical content or hearth diameter of which had not been so very materially increased. I saw a number of furnaces with 15 ft. to 16 ft. diameter hearths which were averaging between 850 tons and 950 tons a day. The most astonishing performance was the average production of more than 600 tons per day by furnaces with hearth diameters no greater than 13 ft.

---

*President, H. A. Brassert & Company.

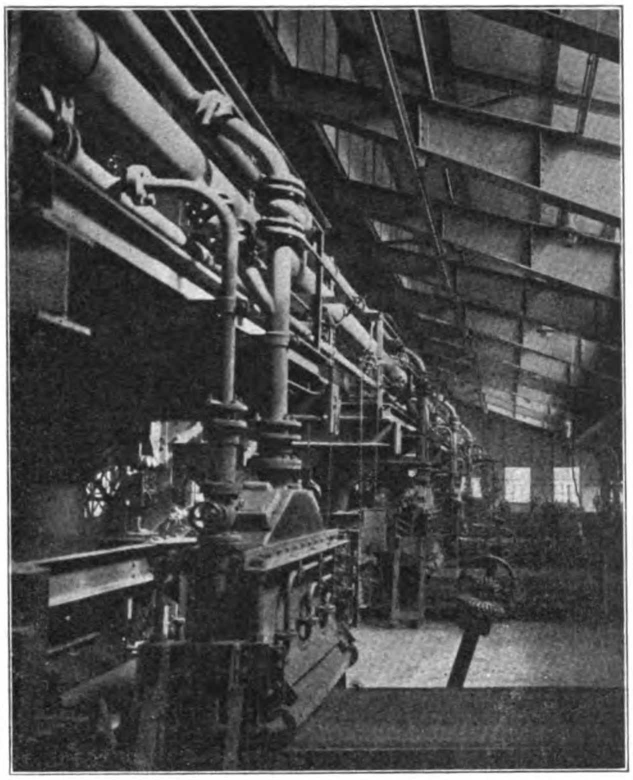
Burden Made More Permeable

Several causes contribute to these results, but the most important one is their more permeable burden, due to an excellent coke and a coarser ore mixture, which generally includes a considerable percentage of briquetted, agglomerated or sintered materials. The latest practice in Germany is to use sinter, which is made principally from ore. The flue dust is mostly briquetted, a large number of briquetting plants being still in use at German plants. The sinter is used in percentages varying from 20 to 40 per cent, although as high as 60 per cent is used by some. The Ruhr coke is made from the best coking coals of the district; in contrast to pre-war practice, the coking process is conducted with more respect for the requirements of the blast furnace; the coke is thoroughly screened and sized. The Ruhr coke is naturally of a good quality, both physically and chemically, and it is not so easy to spoil in the coking process, as is the case with many of our cokes. Their ore mixture generally runs about 52 per cent in iron content, which is somewhat higher than ours. On the other hand, their mixtures are composed of hard ores and soft ores, hematites and magnetites, and sometimes carbonates and limonites. The soft ores, if they contain many fines, are sintered as received, without first undergoing a screening process, except that of scalping off the lumps. The hard ores are generally crushed to small sizes and the resulting fines are added to the sintering mixtures; the former practice of charging big lumps of ore and stone has mostly disappeared. The limestone is generally not as carefully prepared as our best limestone; nevertheless, it is always crushed and screened, whereas before the war it often was not.

Approximately one-half of the iron made for steel works is of the basic open hearth quality containing, however, less silicon than our basic iron and generally more manganese. The other half is basic Bessemer iron which contains only 3 per cent and below of silicon, certainly not an easy grade to make.

I found no plant where they did not have ample blast heat, more than is generally available at American furnaces; this is due fundamentally to the use of clean gas, and certainly is a factor in aiding production and economy.

There are other features of difference in construction and methods of operation, but they seemed to me to have little bearing on results. The question of stock distribution has been given more study in Germany than here, or to express it more correctly they have tried many more variations of tops and distributing devices varying in extent from central gas offtake with lifting bells to side offtakes and lowering bells or a combination of both, with or without deflectors underneath to redistribute the ore, to our type of single bell and hopper in all its variations as to angles and sizes. The methods of mechanical charging also have more or less influence on distribution. But I think it can be stated that after all this experience and experimentation, German furnaces which use the simpler methods have performed as well as those equipped with the more complicated arrangements. Therefore, much value cannot be attributed to their more complicated methods of distribution. In fact, one might conclude that an open stock column counteracts in a considerable measure the general error of distribution.

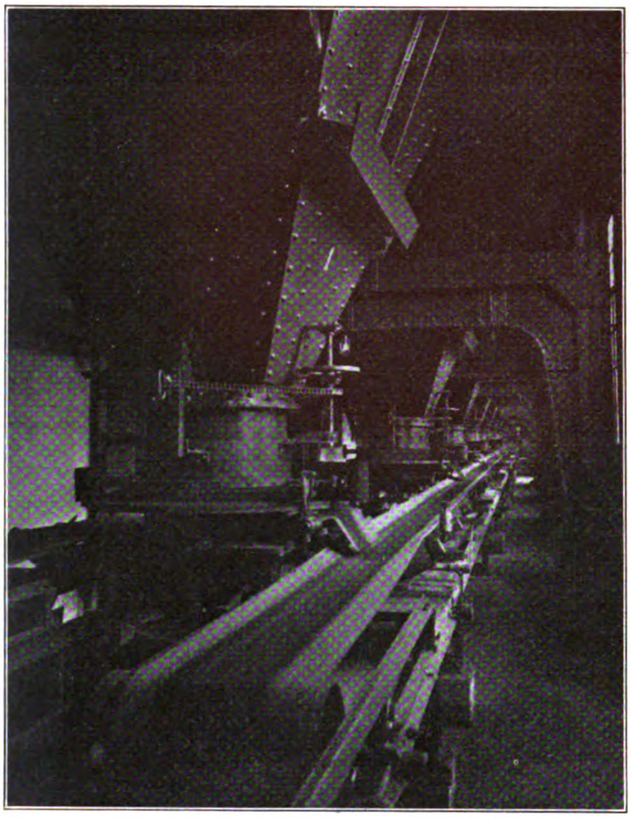


German Dwight-Lloyd installation showing blast furnace gas ignition arrangement.

Furnace Built With Water-Cooled Segments

The German furnace stack has no shell and is built up of alternating water-cooled segments and steel bands which protect and hold the brickwork and which can be easily repaired during operation. They claim that this construction preserves the original lines better than is possible when using a shell, especially when the lining has to be protected by copper plates inserted into the inwall, and such protection is generally necessary when using foreign ores.

The blowing equipment has lately been very much strengthened at most German plants and they can now blow larger volumes against higher pressure, although blast pressures such as are the rule at American furnaces are unknown over there. The blowing equipment mostly consists of gas engines, generally of the single tandem type, although a few turbo blowers have been recently installed and there is a tendency to question at least which is the most economical unit. They blow relatively very large amounts of wind into their small hearths, but in spite of this excessive blowing, as we would consider it, their blast pressures are always low. I would judge that on furnaces producing from 20,000 to 30,000 tons a month, their blast pressures are on an average 4 to 5 lbs. lower than ours, and this includes wind volumes from 60,000 to 70,000 cu. ft. per minute and over. One is immediately impressed with the significance and the great advantages of this practice—the reward of a properly sized burden. It results in the operations remaining very smooth and uniform, even in cases of practice which we would call "overblowing." It entails, of course, a considerable saving in power, a desideratum of great importance in German practice. At any rate, it is an achievement which has revealed to me new possibilities in the direction of greater productions with our present stacks and perhaps larger tonnages with our medium sized furnaces than we now can produce with our largest ones, and most certainly with better practice in regard to fuel consumption, ore losses and general uniformity of operation.



Feed belt at German sintering plant.

German Sintering Practice

In regard to the German sintering practice, they generally sinter the fine ores, as they come, without any classification by screening. They prefer to retain a percentage of the coarser meshes, as it facilitates the sintering process, and in fact they sinter many ores which we would call coarse. In most cases they mix the ores which are to be sintered with roll scale, pyrites, flue dust and other cheap materials. They think it a mistake to first charge the fine ores into the blast furnace, make flue dust and sinter the flue dust produced from them. It is more economical to prevent the production of flue dust by sintering the ore in the first place.

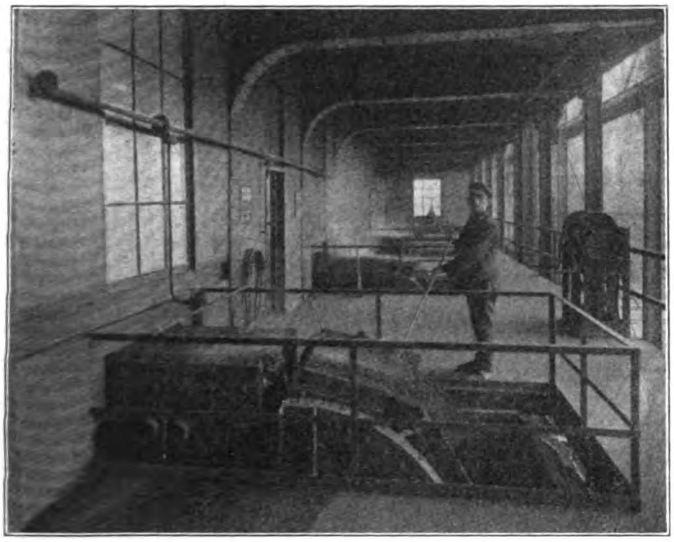
The Germans object to sintering 100 per cent flue dust or in any high percentage, as it retards the process and affects the quality of the sinter. This explains why at plants where they have sintering facilities they have developed a method of feeding the flue dust back into the stack, 30 feet below the stock line, by means of compressed blast furnace gas. This method is apparently quite successful and is capable of handling a great deal more dust than the furnace produces; in other words, one installation can take care of the flue dust production of a group of furnaces. Of course, this is just another proof of how open and permeable the German burden is. It is scarcely conceivable how our furnaces using Mesaba ores could be made to take the dust fed in this way, at the periphery where the column is the densest.

Sintering a portion of the ores not only materially reduces the flue dust production, but it permits blowing a substantially greater volume of wind and still attains low loss and good fuel practice. Channelling of the gases is very much reduced and reduction of the ore takes place more uniformly as between the center and wall sections of the stock column. With the use of 25 to 40 per cent of sinter, which is the percentage most generally recommended, the stock column seems to remain sufficiently open to allow the gases to permeate uniformly over the entire cross section of the various zones in the stack; besides some furnacemen claim that the sinter acts as a filter, catching and retaining the dust which has been produced lower down, preventing its being carried upward with the gases.

The sinter must, of course, be of good and uniform quality, and in this respect I have seen some very excellent practice over there. The German sintering plants are exceedingly well designed and some of them so absolutely clean and free from dust that one wonders how it can be accomplished. The various materials are handled through a set of bins, which generally feed a rubber belt, which is followed by one or more mixing devices of the screw conveyor and concrete mixer type. These devices furnish an absolutely uniform charge, no matter how varied the ingredients. They buy grades of ores which on account of their fineness can be bought below the market price; such fines come from Africa, Sweden and Spain, but among them are grades which are coarser than many of our Mesaba ores. By mixing in fine roll scale, flue dust, pyrites and other waste materials, they assemble a very cheap mixture and the cost of sintered product is generally less than that of a high grade ore and most effective in improving blast furnace results.

The system which has recently found the most favor in Germany is the Dwight-Lloyd, on account of its adaptability to larger output, uniform quality and proper screening, although a number of Greenawalt plants and rotary kilns are used. The new Swedish process, called the A. I. B., is also being considered for new installations of smaller capacity on account of its simplicity.

The beneficial effect of a considerable percentage of sinter mixed in with an ore burden devoid of fines and big lumps and combined with clean, well sized coke, can be well appreciated in the light of the recent investigations on the subject of gas distribution in the blast furnace by S. P. Kinney, P. H. Royster, T. L. Joseph of the Bureau of Mines and Dr. Lent of the Rheinstahl works in Germany. After studying their work, particularly the results at Provo with ores classified by screening, and seeing the performance of German furnaces, one cannot help arriving at the conclusion that more can be accomplished by improving the uniformity of piece sizes in the burden, or, in other words, its uniform permeability, than can be gained by further increases in the diameter of a circular hearth. I agree that the old idea of the elliptical furnace must be revived if we wish to go much further with unit dimensions; in that event the furnace should be elliptical at the stock line as well as in the hearth. On the other hand, I believe that the limit of the large circular diameters can be extended somewhat if the burden is improved by sizing and sintering.



Discharge end of German Dwight-Lloyd machine.

Size of Coke

The importance of sizing the coke is well understood in this country—we have been leaders in it—and many of our by-product coke plants turn out a furnace coke which leaves nothing to be desired as to size of pieces. But we have done little or nothing to improve the structure of our ores. We are burdening our furnaces with from 60 to 100 per cent of ores, the coarsest of which would be considered objectionable to a German blast furnace operator. That we are able to operate economically with so fine a charge is due to the regular analysis of the ores, generally good coke, favorable furnace lines and reliable ponderous equipment. In respect to the latter, I judge from their lighter construction and their more complicated designs, as well as from their far more frequent interruptions of operation, that we have the better practice.

If, following the German practice, we would sinter enough of the finer grades of Mesaba ore, for instance, ores of the Group No. 2 class, so that by mixing these with flue dust, roll scale, pyrites and other iron-bearing materials, we could furnish our blast furnaces with 25 to 30 per cent of a high grade sinter at a favorable cost, our furnaces would make a great deal more iron on a lower fuel consumption, with less wind pressure and less disturbances. The more uniform, better practice would result in savings which would far outweigh the relatively small cost of sintering, and many of our existing furnaces would produce 1000 tons per day more easily than their present output of several hundred tons less.

Joseph G. Butler Dies

Joseph G. Butler, Jr., the pioneer iron and steel maker of the Mahoning Valley, died on December 20, on the eve of his 88th birthday, at his home in Youngstown, Ohio. For about eight years Mr. Butler had been retired during which time he devoted himself to philanthropies and to writing. He was born at Temperance Furnace, Mercer County, Pa., December 21, 1840, educated in the public schools of Niles, Ohio, where he entered the employ of James Ward & Company and had since been intimately connected with the iron and steel business. He was known as "Uncle Joe Butler," the Dean of the industry.

Roll Neck Brasses for Sheet and Tin Mills

(Continued from page 7)

were scrapped because worn out or because broken before they were worn out.

The result is shown below:

	Average amount of wear when scrapped.	Number reported worn out.	Number reported broken.
Tin Mills No. 1 to No. 8.....	$1\frac{3}{8}$ in.	22	4
Tin Mills No. 9 to No. 17....	$1\frac{5}{16}$ in.	17	9
Sheet Mills No. 18 to No. 28.	$\frac{3}{4}$ in.	6	61

Apparently the sheet mills break their bearings sooner than the tin mills do and the above table suggests that it might be profitable to find either a new design or a new analysis that will withstand the shocks of our sheet mills better than the present brasses do.

It is a well known fact that the thinner the gage we roll, the tighter the screws must be set down to care for the spring of the rolls and housings. This means that when idling as well as when working, the bearings are subjected to a much greater friction load, this naturally resulting in an increased wear on brasses.

Our study, however, shows that notwithstanding the above well known facts, we are getting a much shorter life in the heavy gaged sheet mills than in the light gaged tin mills, and we believe this is not due to wear on the bearings so much as to the large number of brasses broken in the sheet mills caused by the greater shock which these mills are subjected to. This defect we believe can be overcome by using a heavier brass or one of greater tensile strength as noted above.

The Use and Abuse of Chilled Rolls

An Experienced Engineer Relates in Concise Form How Rolls Are Manufactured and How They Should be Handled When in Service—Refers Especially to Sheet Mill Rolls

By W. H. MELANEY

OF all the various products made use of in the succesful operation of sheet and tin mills, perhaps the least understood article is the chilled roll.

While chilled rolls of the ordinary type have been in use ever since the sheet industry came into existence, and next to the steel itself from which the sheets are rolled is the most necessary article used in sheet production, there has been little headway made in understanding the peculiar characteristics of this expensive product.

Every one employed in the operation of a sheet mill knows, of course, that he will have more or less roll breakage in spite of all the precautions he may take. But when this breakage does take place scarcely any two of those skilled in the art of rolling sheets will ascribe the same cause for this breakage unless something out of the ordinary has taken place on the mill.

Therefore it has been a mystery to most men why a roll should break at its largest diameter when all of the power to operate the roll must be transmitted through the wabblers and necks, which are not nearly so strong as the body where the break occurs.

If stress was the direct cause of breakage this would not happen, for if this was true a roll should logically break at its weakest point.

We are therefore safe in assuming that stress is not the primary cause of breakage.

Structure of Chilled Rolls

Chilled rolls are of a composite structure as shown by the illustration (Fig. 1).

The outside surface of the working face of the roll is composed of a crystalline structure consisting of iron and carbon, in which the carbon is practically all in the combined form and has a hardness approaching that of hardened tool steel and extending to a depth on most sheet rolls of about three-quarters of an inch. Beyond this depth for perhaps another three-quarters of an inch the crystalline structure is broken up into a mottled mixture usually termed spray, in which the carbon is about equally divided between combined and free carbon, and beyond this point, reaching to the very center of the roll, the free carbon predominates.

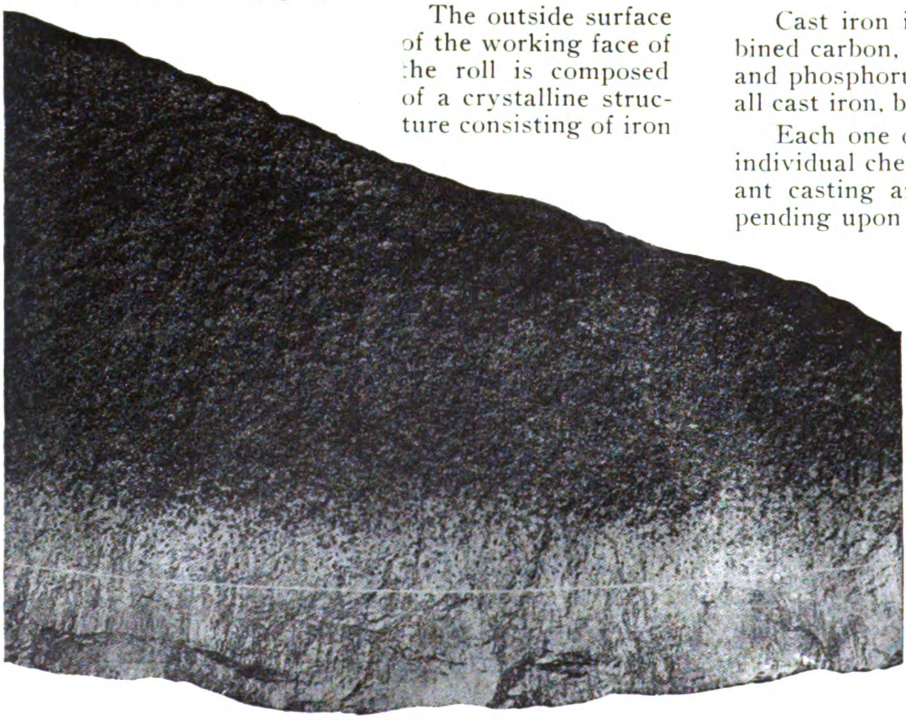


FIG. 1

You will note by looking at the illustration that each one of these different structures has its individual color, and it is also true that each has its individual characteristics.

So if the same condition is applied to each, and this is what must happen, then the effect on each structure will be different.

The novice might ask, why make a roll with such different structures? And the answer is—there is no other way out if cast iron is to be used for its composition.

Chilled cast iron is most desirable because of its cheapness, its hard face and the fact that the heat it must stand in rolling the sheets has very little effect in reducing its hardness.

If, on the other hand, a hardened steel roll was used, its first cost would be almost prohibitive and it would gradually lose its hardness, due to absorbing the heat from the red hot metal it is rolling, as on this type of work no water is used to keep the rolls cool.

Chemistry of Chilled Rolls

Cast iron is a natural alloy containing iron, combined carbon, free carbon, silicon, manganese, sulphur and phosphorus. These seven elements are present in all cast iron, but in greatly varying proportions.

Each one of these confer upon the molten iron an individual chemical characteristic and upon the resultant casting an individual physical characteristic depending upon the amount of each element present.

It is therefore within the power of the foundryman to produce chilled rolls varying greatly in their physical condition by changing the proportion of these chemical elements.

Let me say here that there is no standard mixture for a chilled roll, as the mixture should be so proportioned as to produce a roll best suited for the purpose to which the roll is to be applied.

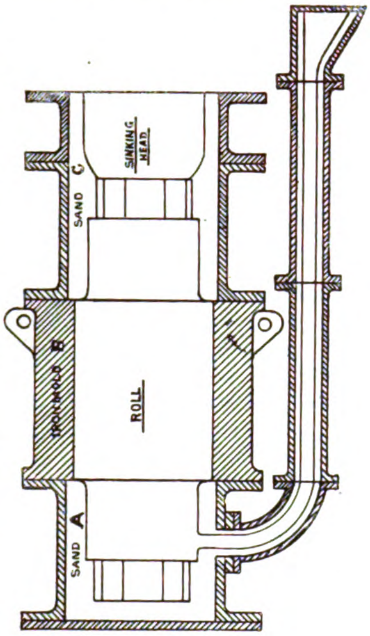
It is a common assumption that when iron is in the molten state all of its carbon is in the combined form, and that an appreciable time is required for the carbon to separate out from the iron and assume the graphitic form.

Therefore, if molten cast iron of a suitable analysis can be congealed or frozen into a solid mass quickly enough, the carbon cannot separate out into the graphitic form and remains in the combined state.

Cast iron in which all of its carbon remains in the combined form has a hard, white, crystalline structure such as is necessary for the face of a roll, but if cooled very slowly part of the carbon separates out in the form of graphite, thus rendering the cast iron comparatively soft and easily machinable, such as in the necks and wabblers of the roll where hardness is not desirable.

How Chilled Rolls Are Produced

An examination of Fig. 2 will explain how these different structures in the same casting are obtained. You will note that the main body of the roll, that is, the part on which the steel sheets are to be rolled, is cast in a thick iron mould which quickly cools the molten metal coming in contact with it, thus producing a hard, chilled crystalline surface, the depth of which depends upon its chemical analysis, while that cast in the sand portion of the mould, and which cooled slowly, are unchilled soft grey iron suitable for the necks and wabblers, while the spray is half way between the two.



Sectional view of chilled roll mold

FIG. 2

Physical Characteristics of Chilled Rolls

The chilled portion of the roll having a hard, very dense structure, has an expansion when heated very much greater and faster than that of the softer grey portions comprising the center portion of the roll.

Now this would be bad enough in itself in producing a very uneven expansion of the roll, but added to this is the fact that the chilled portion is on the outside and must of necessity be the first to receive any heat externally applied (and unfortunately this is the only practical way of applying it), so we are therefore confronted with a condition in which the most rapidly expanding portion of the roll is unduly heated before the inner, or center, portion of the roll becomes warm.

This almost doubles the ratio of expansion between the chilled and sand cast portions of the roll.

As expansion takes place in all directions alike, and as the length of a roll is usually much greater than its diameter, the lateral expansion will measure more than the diametrical expansion.

Assuming that a chilled sheet roll when heated to its working temperature is from a quarter to three-eighths of an inch longer than it is at atmospheric temperature, and that the additional length represents the expanded chilled portion or face of the roll, and knowing that the heated chilled face is expanding double the amount of the cooler grey portion, or center, of the roll, then the logical deduction is that half of this additional length, so far as the soft central portion of the roll is concerned, must be stretch, as the full expansion of the grey iron at this temperature is very much less than this additional length.

Now what happens? If the roll is heated slowly enough the chilled part expanding with the heat drags or stretches the cooler grey portion along with it, and at the same speed, by opening up the grain of the grey iron, giving it a spongy appearance, and this condition takes place every time the roll is heated.

If, on the other hand, the roll is rapidly heated, the chilled portion expands too rapidly to permit the softer, slower expanding center to stretch and the roll is ruptured at the center, and the only thing holding it together is the chilled portion and spray, but there is no indication to the eye that anything has happened, as the roll still remains in one piece as before.

Now this roll will probably remain in service for some time before it finally breaks in two and then the break may occur when the mill is in perfect condition, and the operator is then at a loss to account for the break.

It's a safe assumption that very few of the breaks occur at the moment of the original rupture, and the man operating the mill at the time the roll comes apart is sometimes blamed for the break when he was not responsible.

The deeper the depth of chill on a roll, the faster it is warmed up, and the hotter the bars are that are being rolled on it, the greater the danger of rupture from the above causes and the greater will be the breakage.

Too much reduction or screw per pass is also indirectly a cause of breakage, not so much because of the extra pressure (because the roll is stronger than the housings that contain it) but because the more work that is put on the mill the quicker the rolls warm up.

Care of Rolls in Service

The care of chilled rolls when in and out of service is another matter that rarely receives the attention it deserves.

As heat is the primary cause of breakage, then the less the variation in that heat the less will be the breakage.

The ideal condition, of course, is never to let the roll get cold after it is once heated and to vary the temperature of the roll as little as possible.

Many mills are now providing heated racks in which the rolls are kept fairly hot during the time they are out of service and have noted a decided decrease in their breakage. This is decidedly applicable to the winter months, though good all the year around.

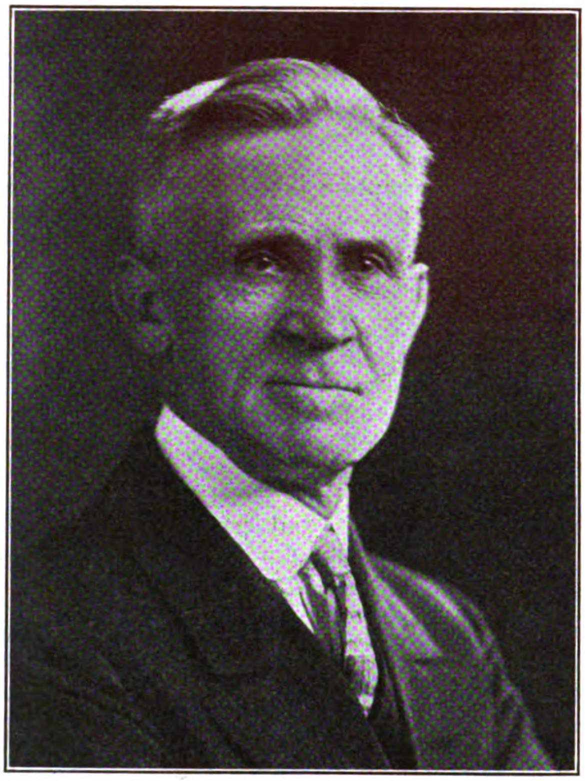
Why Rolls Get Rough

Rough rolls is another cause for grief in a sheet mill and much of the time results from the non-observance of the simplest causes.

Rolls puff up or expand more at the center of their face than they do at the ends of the face. Why? Because the center of the face has no means of getting rid of its heat except by radiation into the air, and air is a very poor conductor of heat. While the ends not only radiate their heat into the air the same as the middle does, but also conduct heat into the necks and housings, thus losing their heat much more rapidly than the center. This necessitates the roll being turned slightly concave along its rolling face in order that it may have a parallel face when hot.

The amount of this concavity depending on the diameter of the roll, width of sheets to be rolled, depth of chill on the roll, time the roll has been in service, and the temperature the roll is permitted to attain in use.

In the first few turns the roll has not acquired the full amount of its expansion and is still more or less concave, and as a consequence the face at each end becomes rough and must be scoured with the carborundum block. This happens because the bearing on the face of the rolls is too narrow to carry the pressure exerted upon them by the screws without tearing small particles out of the face of the rolls and the pack, and this would happen even if nothing was rolled on the rolls so long as the rolls were permitted to run with their faces in contact while hot.



W. H. MELANEY

The wider the bearing on the face of the roll becomes the less will be the roughness until, when the rolls have expanded sufficiently to permit a bearing entirely across the face, little roughness results and less scouring is required. This is one reason why most of the roughness occurs in the forepart of the week. Another reason is that after using the roll a couple of days the surface has become denser from use and so less liable to rough. Of course, too much screw on the pack will also cause roughness by exerting more pressure than the face of the roll can stand without tearing out.

Using Steam on Rolls

When heavy sheets are being rolled, or when the mill is being pushed to produce tonnage, the rolls ofttimes in spite of the concavity turned in them become too full in the center and then the bearing in the center rapidly roughs up, requiring much scouring of the face. Then some extra means must be provided to reduce this fullness in the center of the rolls and steam has been found to be admirable for this use. Many wonder why hot steam should be used to reduce the temperature of the hot rolls, but it should be remembered that even hot steam is cool in comparison with the much hotter roll, and that steam is only evaporated water, and water is one of our best conductors of heat.

Therefore the heat is rapidly absorbed from those portions of the roll with which the steam comes in contact. And right here is where more trouble usually ensues.

Abuse of Steam

It has been customary in the past to force a jet of steam into a sheet steel receiver, called a spreader, in which an effort was made to spread the steam in a flat sheet over more or less of the face of the roll.

This spreader was located usually beneath the fore plate at the center of the rolls some distance back from the roll face.

Its object was to put most of the steam on the center of the roll face where it was most needed in order to reduce the over-expanded middle of the roll. This was only a makeshift and not very satisfactory.

This was later supplanted by a perforated pipe of a given length varying with the length of the roll, which more accurately distributed the steam over a larger area. But in most cases the pipe was so placed that the bottom roll received the most of the steam, while the rolls were running idle, and the top roll only such steam as drifted upward, and during the time the pack was in the rolls the top roll received no steam at all as the pack itself cut off any steam from reaching the top roll. The result being an uneven effect of the steam on each roll.

Also under this system only such steam as is required the reduce the convexity of the face of the roll could be used, and when an effort was made to force sufficient steam on to the rolls to reduce the temperature of the entire roll a new trouble presented itself.

Rough Streaks on Rolls

That is, a wide, rough streak appeared on the face of the rolls each side of the center which the steam only aggravated instead of diminishing. Why?

As most of the steam applied to the rolls came directly in contact with the center of the face, the center soon developed a concave band about 12 in. wide, while a slight ridge of convexity appeared upon each side of it because the steam did not reduce these parts of the face quickly enough.

These ridges produced a rough streak on the face of the pack on each side of the center which was very annoying, and the more steam that was used the worse it got.

Using Steam on Both Rolls

Finally, some one with more than the average forethought conceived the idea of putting steam on both rolls at the same time from two separate pipes and a single steam connection. That is, a separate pipe was used for each roll but connected to a common supply pipe and controlled by one valve.

These are located on the catchers' side of the mill—the pipe supplying steam to the top roll just a few inches above the guides, so as to be out of the road of the delivery of the pack, and the pipe for the bottom roll the same distance beneath the guides.

These pipes are placed quite close to the face of the roll and extend completely across the face of the roll—in fact, for convenience and stability of their installation they extend completely through the windows of each housing and are held tight against the inside surface of the window of housing by iron clips screwed to the face of the housings and through which the pipes pass.

This arrangement holds the pipes very rigid and prevents dislodging the pipes should the pack happen to touch the top pipe, and as a 1 in. pipe is sufficiently large, they are not in the road.

These pipes are capped on their outer end and a small hole 1-16 in. in diameter is drilled through the lower edge of the cap, so that the water from the condensed steam will drain out.

For convenience in changing rolls the steam connection is made at one end of the mill outside the housing and a wheel valve installed here to control the steam, one valve being used for both pipes, and by placing a union between the valve and the pipes, by disconnecting the union the two pipes are assembled together and a "T" provided for a common steam connection, these pipes can be removed by slipping them through the clips and replaced after the mill has been changed.

Even Distribution of the Steam

These pipes are perforated on the side next the rolls to within a short distance of the ends of the roll face and the proper distribution of the steam is taken care of by having the holes near the center of the roll face larger in diameter and gradually reducing the diameter of the holes toward the ends of the roll.

This gives proper distribution of the steam by applying most at the center and gradually tapering off toward each end so that the proper circle can be kept in the face of the rolls.

The excellency of this arrangement is that unlimited steam can be used on the mill in order to keep down excess temperature in the whole roll, thus preventing breakage without distorting the face of the roll.

Blast Furnace Developments in 1927

Although There Have Been No Radical Departures in Furnace Construction or in the Manner of Handling Furnaces Nevertheless Many Minor Advances Have Been Made

By H. A. BERG*

THE year 1927 will go into the records of the iron and steel industry in the United States as one of the very few years in recent times during which the construction of an entirely new blast furnace plant was neither started nor completed. This fact, however, was not due to lessened activities in the production of pig iron nor to any lack of progress in the design and construction of furnaces, inasmuch as the output of pig iron for the year 1927 will not fall much below the output of the record years. It was due principally to the fact that the art of rebuilding, and of wholly or partially re-equipping existing furnaces to furnaces of larger capacities had, during the year immediately preceding 1927, progressed enormously and a very large percentage of furnaces had been so remodeled.

During the year 1927 the average number of furnaces operating was about 200, whereas in the record production year of 1923 there were an average of 278 blast furnaces active. The tonnage of pig iron produced for the year 1927 will be found, when statistics are completely compiled, to be close to 36,500,000 tons compared to the record of 1923 when 40,250,000 tons were produced. These figures clearly indicate the rapid tendency toward larger and fewer units.

This lack of construction of new blast furnaces during the past year, however, has not had a consequent retarding effect in the progress of engineering and construction of more efficient furnace units. Considerable progressive thought and effort on the part of operators and engineers has been successfully and with good results employed to increase efficiencies and to lower costs.

Severest kind of competition in the steel industry, as well as in the marketing of merchant pig iron during the year, has made necessary more than ever before the lowest possible operating and manufacturing costs.

The very important question of first cost of installation and the consequent return on invested capital has been given more serious consideration and study than ever before with the result that throughout the industry a keener interest has been shown in engineering and operating refinements.

Whereas the progression and development of every phase of blast furnace practice, equipment, management and safety has been marked, it would nevertheless be hard to point out any individual item directly connected with the blast furnace which indicates a radical or decisive departure from the immediately preceding years. The progress and development has been almost entirely along lines followed heretofore, and has been more of a refinement of existing means than of introducing departures therefrom.

Gauging the progress and development in the blast furnace yield by reduced manufacturing costs, we believe that the year of 1927 can be truly said to be one of the most progressive.

Large Furnaces Lower Costs

The most important factor contributing to these lower production costs has been, of course, the larger furnaces. Improved methods and equipment and closer management attention to every phase of operation has, of course, also contributed to the lower costs. The large hearth and large capacity furnace has continued to demonstrate that with increased size has followed increased tonnage, decreased coke consumption, improved practice and lower operating costs.

At the end of 1927 there were several furnaces of 24 ft. 0 in. or more hearth diameters, either in operation or being rebuilt. One furnace of this size in the Pittsburgh district has reached a monthly average production of 900 tons, and several furnaces over the country of this or slightly less size have produced daily tonnages for extended periods of 800-850 tons and over.

---

*Vice President, Arthur G. McKee & Company.

It is interesting to note that two steelworks furnaces of about 13 ft. 0 in. in hearth diameter, and wheelbarrow filled, are still operating.

Particular attention has been paid to height of bosh, batter of inwall, and to proper diameter of stock line and big bell to effect proper or improved disposition of the stock in the furnace. Some furnaces have adopted with evidently good results a proportionately smaller big bell than has heretofore been considered orthodox.

Other furnaces have adopted the more flexible means of installing or reinstalling the McDonald distributors. Several furnaces have increased stocklines up to 19 ft. in diameter, and introduced big bells up to 14 ft. 6 in. in diameter.

Inwall cooling has been regarded with increased favor to maintain furnace lines and consequent regular operation, or to protect furnace lines from destruction caused by irregular operation. Thorough inwall cooling by removable cooling plates has especially demonstrated its worth on high silicon irons, silveries, ferrosilicons, Spiegel iron and ferro-manganese.

Development in charging can be said to have been almost entirely devoted to increased size of equipment to meet the requirements for the larger tonnages to be handled. Skip and scale cars of 200 cu. ft. capacity are in use, revolving distributors are almost universally adopted, and a refinement of selective control for such distributors has been added by several furnaces so as to enable the operator to change the cycle of filling at will without disturbing the cycle of distribution.

Preparation, Selection and Handling of Materials

The preparation, selection and handling of raw materials has received continued and intelligent attention. Further recognition has been given the importance of the proper selection of coking coals, both from analyses and uniformity point of view, and of the advantage of cokes of higher fixed carbon content. When the available coals are high in impurities, improved methods of mining, picking and of cleaning or washing the coals have been installed, or are being considered. Combustibility of coke, sizing and screening have to a greater extent than ever received attention. Likewise, smaller coke bins at furnaces, so as to reduce breakage, have been recognized as desirable; the coke bin being given its proper function as an insurance of continuous supply for the charging mechanism instead of the formerly often made installation of large coke bins for storage.

Screening and breeze handling has kept abreast with the increased demand for cleaner coke and the larger tonnages to be handled.

Thorough Gas Cleaning

The increased demand for lower costs and specifically for lower coke consumption and higher credits for excess furnace gases has accentuated the importance and desirability of thorough gas cleaning. Gas cleanliness of from .25 to .75 grains of dust per cu. ft. of gas, only a few years ago acceptable for blast furnace, stoves and boilers, is today specified at .05 to .1 grains per cu. ft. The numerous installations of Feld type washers during the past year testify to the importance of this feature. Gas of this cleanliness together with proper burner and other equipment has made possible efficiencies in stoves and boilers heretofore unattainable. This combination has also permitted stoves of less heating surface to meet requirements of increased furnace sizes. Gas of the cleanliness above mentioned is also being used for metallurgical heating either as an admixture to coke oven gas or alone.

Disintegrating washers of improved design are being brought out to properly prepare gas for stoves, boilers, metallurgical heating and coke ovens. This type of washer has heretofore been used exclusively for preparation of gas for gas engines. The announcement of the actual building of a Koppers by-product coke oven plant in Chicago territory using straight blast furnace gas is of pertinent interest, and this installation will be the first of its kind providing for gas washing to a cleanliness of less than .01 grains per cu. ft., and it will also when put in operation open a field long contemplated by various companies, and prepared for in oven design and construction but not actually tried out.

Increased demands by operators for elimination of entrained moisture has brought out gas washers with efficient elimination as well as auxiliary devices for elimination and has also prompted a number of installations of different types of gas preheaters. Progress in gas washing is also evident from the fact that recent specifications call for units capable of handling 125,000 cu. ft. of gas per minute.

An adjunct to gas washing—the recovering of the dust or sludge in suitable condition for use in the sintering plant—has been given widespread and serious attention. Plants that heretofore have not at all or only partly recovered washer sludge are making complete recovery installations, including settling basins or thickeners, classifiers, filters and driers for the reduction of moisture content to a desirable point for sintering plant. The drier installation for filter cake is novel in the blast furnace field. The importance of this complete recovery of blast furnace dust can best be visualized by stating that about 70 per cent additional dust is recoverable over and above what is normally caught dry in dustcatchers and whirleys. When it is considered that this dry dust generally, in the United States, amounts to from 200 to 300 lbs. per ton of pig iron, the potential value of the recovery of 140 to 210 lbs. per ton pig iron of sludge of fairly high iron content is clearer.

New equipment for dry cleaning of gas of considerable interest is the Sirocco Collector. It again brings attention to the merits of dry cleaning with its avoidance of the problem of separation and preparation of sludge from gas washer discharge water.

Hot Blast Stoves

The development in hot blast stoves and their operation has been mainly in the provision of more automatic operation and regulation of hot blast and the provision for and use of higher hot blast temperatures. Several plants using lake ores are using hot blast temperature of 1500 deg. F., and in a few instances even higher. With cleaner gas and pressure type gas burners, temperatures of much higher range have been produced on stoves of limited heating surface. The usage of hot blast temperatures of this range has required further study of refractory materials for stove construction.

Following German practice and construction stoves of normal size, but with large heating surfaces, have been developed through the use of smaller checker openings and departure from the orthodox square checkers to round octagon or irregular openings. Such stove design is, of course, only possible with ultra-clean gas.

Development in blowing equipment has mainly consisted in improved design. Turbo blowers of increased size, higher efficiencies, improved control and greater range have replaced not only reciprocating steam engines, but also gas engines and older and smaller turbo blowers. Turbo blowers of 70,000 cu. ft. capacity have been built.

Boiler Installations

Boiler installations have been in continuation of established practice, somewhat following the lead of central power stations. Boiler houses have been built of high horsepower units, high pressure, higher rating and equipped with superheaters, economizers, preheaters, pressure gas burners, draft and combustion control and efficient installations for using auxiliary fuels, such as coke breeze, tar and pulverized coal.

It is notably of interest that a power unit of 50,000 kw. generator size is being built—of course, in connection with one of the very largest blast furnace plants in the country.

Mention of improvements to equipment should not omit increased installations of equipment such as automatic mud guns, automatic cinder-bots, automatic gauge rods, gas cut off valves, double compartment tuyeres, pug mills for handling and preparing dust-catcher dust, electrically operated bell rigs, electric elevators for serving furnace tops and top platforms of stoves.

Some of this kind of equipment contributes to ease of operation and lower costs. Some is almost essential to the operation of the larger furnaces now used, and most of such equipment contributes considerably to elimination of hazards and reduction of accidents.

Wonderful results in prevention of accidents expressed in fewer accidents and fatalities are almost universally recorded in the steel and blast furnace plants during 1927.

Pertinent to development in the blast furnace field insofar as the product will be used in the replacement of pig iron is the building by the United States Steel Corporation of a Hornsey-Wills process plant at Lorain, Ohio, for the production of iron sponge briquettes. This plant is nearing completion and results obtained will be noted with interest by everyone connected with the blast furnace industry. Regarding it, Mr. Forbes of the United States Steel Corporation has recently written: "This question of impurities in blast furnace iron brings us to the subject of the quality of iron made by the direct reduction of iron from its ores at low temperatures resulting in a reduced iron product which is free from such impurities including carbon, silicon and also phosphorus and sulphur when not inherently chemically combined with the iron, and above all else free from nitrogen. A plant to demonstrate this question is now being constructed in this country on a sufficiently large scale to commercially demonstrate the various points involved. In the meantime there is evidence that the theories of improved quality which have been advanced for this process are sound."

In England the old and interesting subject of dry blast has been to some extent revived in actual practice by installation of drying plants using Silica Gel.

Study of the developments in the blast furnace field abroad indicates Germany keeping well abreast of American practice both as to production per furnace and fuel efficiency.

It is of special interest to note numerous new blast furnaces being built or contemplated outside of the United States—almost all over the world—and almost in every case tribute is paid to developments accomplished in the blast furnace field in the United States in the employment of American design, equipment and practice.

United States Leads the World in the Utilization of Its Water-Power Resources

The extent of the industrial development of a nation, which is the modern measure of its civilization, can probably be gauged best by the extent of its use of mechanical energy. For this reason it is interesting to compare the extent to which the water-power resources of various countries have been utilized and the progress which is being made in building new plants. In both respects, according to an estimate made by the Department of the Interior through the Geological Survey, the United States leads all other countries of the world, and in the capacity of its constructed plants it nearly equals all Europe. The total for the United States at the end of 1926 was 11,700,000 hp. for plants of 100 hp. or more, as against 13,100,000 hp. in Europe, presumably for plants of all sizes. In the six-year period 1921 to 1926 the capacity of constructed plants in the United States of 100 hp. or more increased 3,800,000 hp., while in Europe the increase in plants of all sizes was 4,200,000 hp. During the last three years of that period, however, the rate of increase in the United States was much greater than during the first three years, whereas the rate of increase in Europe showed a decline. The leading countries in Europe in the use of water power and the capacity in horsepower of their constructed plants in 1926 are as follows: Italy, 2,300,000; France, 2,000,000; Norway, 1,900,000; Switzerland, 1,850,000; Sweden, 1,350,000.

The developed water power of Africa amounts to only about 14,000 hp., but Japan has built plants aggregating 1,750,000 hp., and India 200,000 hp. New Zealand has some large plants under construction, but those completed have a capacity of 60,000 hp. The Dutch Islands of Java, Sumatra, and Celebes have plants of 80,000 hp. Tasmania's plants have a capacity of 75,000 hp. Australia depends mostly on fuel plants and has utilized only 2,000 hp. of its water-power resources.

In South America, Brazil leads the other countries by a wide margin, with 500,000 hp., most of it used in Rio de Janeiro and Sao Paulo. Chile's plants amount to 114,000 hp., and Peru's to 55,000 hp.

Coming back to North America we find that Mexico has plants with a capacity of 300,000 hp. A large part of this capacity is in plants supplying Mexico City and there is not much activity in building new plants. Newfoundland has a large new plant for the manufacture of paper that increases its total to 160,000 hp. But the only real competitor of the United States in the whole world is our neighbor Canada, whose plants had a total capacity of 4,556,000 hp. at the end of 1926, an increase of 2,138,000 hp. since 1920.

Notes on Open Hearth Furnaces

Consideration Is Given to Furnace Operation with Particular Emphasis on the Importance of Educating the Furnace "Helpers"—Information Is Practical

By **MARTIN J. CONWAY***

THE open hearth is the backbone of a steel plant, yet it is difficult to explain why so much time and expense is devoted to the construction of an open hearth furnace and then comparatively little attention given to the education of the men who will largely be responsible for its success or failure. The theory for definite calculation regarding efficient operation is deplorably vague.

A steel mill must produce certain grades of steel of a quality and tonnage that will meet a competitive market. This tonnage must be divided among a group of furnaces that are maintained and kept as near as possible on a schedule of production, at all times having one or more fast furnaces to in a measure balance the tonnage of those slowing down on account of advanced age.

Dimensions must be in accordance with furnace capacity. Ports, downtakes, size of openings in checkers and flues must all be in proportion. Large downtakes to accommodate the waste gases, with flues large enough to speed up the cleaning as well as to allow the gases to flow freely to the furnace are most essential, the air regulation being taken care of with suitable valves and the necessary throttling to gases being taken care of with the size of the ports.

Sufficient opening must be allowed in checkers not to retard the outgoing gases, yet at the same time conserve sufficient heat for economy. One of the most serious mistakes often made in furnace construction is the building of passageways large enough only to accommodate the gases at the start of the campaign and at a time when the furnace should be at its best, it is necessary to shut down and clean out checkers and flues as well as downtakes and slag pockets.

Checkers should be laid in such a manner where as much surface is exposed to the heat as possible and yet in a way that they can be most readily cleaned without long interference with the furnace operation.

Open hearth furnaces must be built with every regard to expansion and contraction and every consideration must be given to this most important factor to offset the increasing demand for speed in lighting up a new furnace.

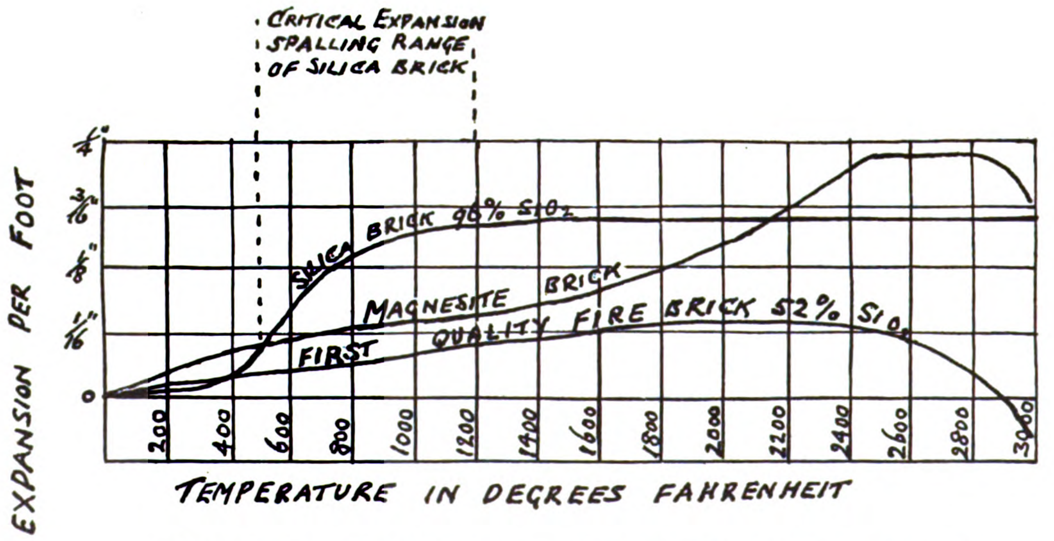
Every thought is intent on making a furnace with lines that will utilize the heat in the fuel gases to the fullest extent, which is as it should be.

Fuels

Except in localities where natural gas is available or where tar oil or coke oven gas can be obtained at a nominal figure, producer gas is used, and its advantages are the economy with which it can be generated and the ease with which it can be regulated.

Coal is the standard fuel used for gasification and it has a very particular bearing on the quality of the product produced and can only be used where the sulphur content is sufficiently low not to interfere with the analysis of the finished product. This sulphur content should not be more than 1.25 per cent. An hour's additional time in making a heat on account of high sulphur coal is costly, and coal high in sulphur content though low in first cost can be very costly in the long run.

Coke oven gas can be used to advantage in an open hearth furnace. Where tar or oil are available only a



THERMAL EXPANSION OF REFRACTORY BRICK

---

*Fuel Engineer, Lukens Steel Company.

very small quantity introduced with the coke gas gives the desired luminosity to the flame. Coke oven gas alone is not luminous, and is exceedingly hard to control and operate by the average open hearth furnace man. The practical furnace man is guided to a greater or lesser degree by the appearance of the flame and where this is not readily discernible he is at a disadvantage and may do serious damage to the refractories.

Coke oven gas can be introduced through a burner in combustion with tar and oil or run independently. It lends itself very readily to proportional control devices, therefore resulting in a low B. t. u. consumption per ton of steel produced.

Oil and tar are admirable fuels and where the purchase price of these fuels makes their use practical, can be used to good advantage. This is especially notable in plants where there is a fluctuation of the supply of coke oven gas. A burner can be made that will accommodate coke oven gas alone or tar or oil independently.

Open Hearth Fuels—Amount of Different Fuels for Equal Heat Units.

Oil. Gal.	Tar. Gal.	Coal. Lbs.	Natural Gas. Cu. Ft.	Coke Oven Gas. Cu. Ft.	Total B. T. U. ....
1	.84	13.5	135	245	135,000
1.185	1.	16.	160	291	160,000
148.	125.	2,000.	20,000	36,394	20,000,000
7.41	6.25	100.	1,000	1,818	1,000,000
4.07	3.44	55.	550	1,000	550,000

In the comparison of B. T. U. values the coal is figured as 12,500 B. T. U. per pound with an 80 per cent gasification efficiency at the producers, or 10,000 B. T. U. per pound of coal gasified as being delivered to the furnace.

Cost of Different Fuels for Equal Heat Units—Using 6,000,000 B. T. U. Per Ton

	PRICE OF COAL PER NET TON.										
	$2.50	$2.75	$3.00	$3.25	$3.50	$3.75	$4.00	$4.25	$4.50	$4.75	$5.00
Oil, gallon	.025	.027	.028	.030	.032	.033	.035	.037	.038	.040	.042
Tar, gallon	.030	.032	.034	.036	.038	.040	.042	.044	.046	.048	.050
Natural gas, 1,000 cu. ft.......	.208	.221	.233	.246	.258	.271	.283	.296	.308	.321	.333
Coke oven gas,, 1,000 cu. ft....	.115	.121	.128	.135	.142	.149	.156	.163	.170	.176	.183
Producer gas, 600 lbs.........	1.250	1.325	1.400	1.475	1.550	1.625	1.700	1.775	1.850	1.925	2.000

All prices f. o. b. the plant. Included in the producer gas item together with the cost of coal is the cost of unloading the coal and crushing it; cost of labor, steam, power, light, water, repairs and maintenance. The figure used is fifty cents ($0.50) per ton of steel.

In comparing oil and tar cost an allowance of fourteen cents ($0.14) per ton of steel was made for labor in unloading tank cars and delivering oil to furnace together with the cost of steam used in heating, pumping and atomizing.

Values Used Per Ton of Steel.

Oil	44.44 gallons
Tar	37.5 gallons
Natural gas	6,000 cubic feet
Coke oven gas....................	10,909 cubic feet

Furnace Construction

The construction of a furnace for coke oven gas is in the main similar to the construction of a furnace for tar or oil, i. e., both gas and air chambers are used for preheating the air. The slag pockets are built with no division wall and the port construction is only a doghouse type port with low bridge wall on either side. The construction of the flues is simplified, there being no need for high priced valves. Most essential in furnace construction and upkeep is to have the wear on the refractory as uniform as possible in order that all parts of the furnace will age simultaneously and will have given maximum service at the end of the campaign.

Roof life is most vital in that the maximum run from the furnace is contingent on the roof. The life of a furnace is largely dependent on the furnace man. If he is careful, knows his business, knows when to feed heat and when not to, by so doing he can prolong the campaign of the furnace.

Adequate water cooling for ports, bulkheads, etc., all have a most important bearing. The sloping backwall has done more where used than any single move made in the open hearth to relieve repairs and costly waste of time to replace new backwalls. The shutting off of gas on an open hearth furnace is a costly proposition and the loss is hard to compute. The waste of fuel to get the furnace back to temperature, the additional pig iron necessary and the expansion and contraction of refractories. Any move that will relieve the necessity for shutting a furnace down if only for an hour is money well invested. The dolomite machine has not only relieved an enormous amount of hard work, but can do a far more efficient job than a group of men can with shovels; material is not scattered over the charging floor and furnace bottom, but is only laid exactly where the operator wants it. It relieves the necessity of men having to leave their furnace and go to other furnaces to help make bottom and it does the job in much less time.

Furnace Operation

To obtain maximum speed on an open hearth furnace, there are essentials necessary for the operator to take advantage of, i. e., make a bottom quickly, use only sufficient material, avoid getting banks too heavy. There is more danger from break-outs with abnormally heavy banks than light ones. The furnace must be charged as promptly as possible, and the lime must be evenly distributed over the bottom. Fuel conditions must be at their very best during melting for this period is where time is made. The furnace must be reversed regularly as the heat progresses and the stack damper and air valves brought into use. After the heat is melted and under a heavy blanket of lime, it does not take as much fuel as in melting. This is a good time to clean fires in the gas house where producer gas is used. If the heat is melted hot, then during finishing period and tapping there will be no trouble from cold heats. One cannot emphasize too strongly the vital side of the man with the blue glasses. Open hearth

(Continued on page 30)

Review of Iron and Steel Literature for 1927

A Classified List of the More Important Books, Serials and Trade Publications During the Year; with a Few of Earlier Date Not Previously Announced

By E. H. McCLELLAND*

THIS list constitutes the eleventh annual review of iron and steel literature compiled for BLAST FURNACE AND STEEL PLANT. An attempt has been made to list the more important publications of 1927, together with certain publications dated 1926 but not available for inclusion in the list compiled near the end of that year. The list is concerned only with separately published books and pamphlets. It does not list magazine articles nor include books which deal only in part with iron and steel. The "Handbook" of the American Society for Steel Treating has been supplemented by new material during 1927 but this has appeared in loose-leaf form and is merely incorporated with the material of earlier date.

Where possible, the compiler has examined the publications listed, but in some cases the publications were not accessible and the only information regarding them was in technical journals and publishers' lists, which, unfortunately, are not always either accurate or complete. Prices are sometimes particularly hard to verify promptly, certain sources of information occasionally differing very widely. The prices here given are, therefore, probably in some cases incorrect.

Some official publications of the United States government have been grouped at the end of this list, but space is not available for inclusion of all the material appearing serially. The "Industrial Standards" series of the Bureau of Foreign and Domestic Commerce includes many specifications for iron and steel products. These are standards adopted by the American Society of Testing Materials, published with text in English and Spanish, and priced at five cents each.

GENERAL

Iron Ores

England—Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol. 10. Iron Ores; The Haematites of the Forest of Dean and South Wales. Ed. 2, 101 pp. 1927. H. M. Stationery Office, London.

Grout, Frank F. Geology and Magnetic Deposits of Northern St. Louis County, Minnesota. 220 pp. 1926. University of Minnesota, Minneapolis. (Minnesota Geological Survey, Bulletin 21.)

Joseph, T. L., and Kinney, S. P. Minnesota Manganiferous Iron Ore in Relation to the Iron and Steel Industry. 101 pp. 1927. University of Minnesota, Minneapolis. (Minnesota School of Mines Experiment Station, Bulletin 12.)

Published as co-operative work with the U. S. Bureau of Mines. Listed also as Bulletin of the University of Minnesota, vol. 30, No. 8.

Pickands, Mather & Company. Analyses, Lake Superior Iron Ores. 17 pp. 1927. Cleveland.

Young, George A., and Uglow, W. L. Iron Ores of Canada. Vol. 1, British Columbia and Yukon, 253 pp. 1926. Geological Survey of Canada, Ottawa. (Economic Geology Series, 3.)

Metallurgy, Testing, Working

Aitchison, Leslie. Les aciers de construction; translated by A. Michel. 379 pp. Ch. Béranger, Paris. 67 fr.20.

American Iron and Steel Institute. Year Book. Vol. 16. 1926. 533 pp. 1927. The Institute, New York. $5.

Contains proceedings of the twenty-ninth and thirtieth general meetings.

American Rolling Mill Company. Armco Iron; Its History and Service. 48 pp. 1927. The Company, Middletown, Ohio.

American Rolling Mill Company. A Visit to Armco East Side Works. 23 pp. 1926. The Company, Middletown, Ohio.

American Society for Testing Materials. A.S.T.M. Standards (Issued Triennially). 2 vol. 1927. The Society, Philadelphia. $14.

The first 514 pages of vol. 1 are devoted to standard specifications for ferrous metals.

Archiv für das Eisenhüttenwesen; Fachberichte, Herausgegeben vom Verein Deutcher Eisenhüttenleute. Monthly. Verlag Stahleisen, Düsseldorf. 50m. a year.

A new periodical superseding the "Berichte der Fachausschuesse des Vereins Deutscher Eisenhuettenlente," which is discontinued. First issue is July, 1927. Well printed but price is unduly high.

Ausgewählte Methoden für Scheidsanalysen und Kontradiktorisches Arbeiten bei der Untersuchung von Erzen, Metallen und Sonstigen Hüttenprodukten. 146 pp. 1926. Gesellschaft deutche Metallhütten- und Bergleute E. V., Berlin.

Blomqvist, Eric Anders. An Investigation of the Physical Properties of Some Nickel-Iron Alloys of the Invar Group. 14 pp. 1926. Rensselaer Polytechnic Institute, Troy, N. Y. (Engineering and Science Series, 13.)

Bullens, Denison K. Steel and Its Heat Treatment. Ed. 3, 564 pp. 1927. John Wiley & Sons, New York. $5.

In this edition, chapters are added to cover recent developments.

Carnegie Steel Company. Carnegie Beam Sections; Profiles and Properties Pertaining to a new series of Structural Steel Beams and Column Sections. 49 pp. 1927. The Company, Pittsburgh.

Dimensions of standard sections made by this company.

Carnegie Steel Company. Carnegie Beam Sections; Profiles, Properties and Safe Loads for Additions to New Series of Structural Steel Beams and Column Sections. 19 pp. 1927. The Company, Pittsburgh.

Carnegie Steel Company. Carnegie Beam Sections; Profiles, Properties and Safe Loads for New Series of Structural Steel Beams and Column Sections. 170 pp. 1927. The Company, Pittsburgh.

---

*Technology librarian, Carnegie Library of Pittsburgh.

Chevenard, P. Recherches expérimentals sur les alliages de fer, de nickel et de chrome. 144 pp. 1927. Gauthier-Villars et Cie, Paris. (From "Travaux et Mémoires du Bureau International des Poids et Mesures, vol. 17.)

Cotel, Ernst. Der Siemens-Martin-ofen. 150 pp. 1927. Otto Spamer,Leipsic. 18m.

Encyclopedia of iron work. 1927. Ernest Benn, Ltd., London, 42s.

"This is a book of plates—320 of them. They illustrate examples of hand-wrought ironwork from the Middle Ages to the end of the 18th century, and they are introduced with historical notes by Mr. Otto Hoever." *Engineer,* Nov. 4, 1927.

England.—Research Department, Woolwich (War Office). Influence of Molybdenum on Medium Carbon Steels Containing Nickel and Chromium. 59 pp. 1927. H. M. Stationery Office, London. 3sh. 6d. (R. D. Report, 67.)

Etchells, Ernst Fiander. Modern Steelwork; a Review of Current Practice in the Application of Structural Steelwork to Buildings and Bridges. 276 pp. 1927. Nash & Alexander, Ltd., London, 5sh.

Finkl (A.) & Sons Company. Mo-Lyb-Die products; forgings. Ed. 2, 66 pp. 1927. The Company, Chicago.

Title from cover.

Loose-leaf trade literature dealing with various alloy-steel products.

Foucard, A. F. Les Traitements thermiques des aciers. 200 pp. 1926. Masson et Cie, Paris. 8fr.50.

Frauche, G. Traitement thermique de l'acier et ses essais. 239 pp. H. Desforges, Paris. 18fr.

Gathmann Engineering Company. Big-End-Up versus Big-End-Down Ingot Production, as Related by the Originator of Gathmann Methods. 24 pp. 1927. The Company, Baltimore.

Trade literature, outlining development of Gathman ingot mold. Includes list of United States patents controlled by this company.

Gudtzoff, N. T. Steel. 59 pp. 1926. Moscow.

Printed in Russian.

Herty, C. H. Jr., and others. The Physical Chemistry of Steel-Making; the Solubility of Iron Oxide in Iron. 69 pp. 1927. Carnegie Institute of Technology, Pittsburgh. 75 cents. (Mining and Metallurgical Investigations, Bulletin 34.)

Co-operative work with the U. S. Bureau of Mines.

Horn, Hans A. Die Eisenblech-Schmelzschweissung. 88 pp. 1926. Hanseatische Verlagsanstalt, Berlin. 3 m. (Schriften aus "Theorie und Praxis der Schmetzschweissung.")

Horn, Hans A. Die Gusseisen-Schmelzschweissung. 94 pp. 1927. Hanseatische Verlagsanstalt, Berlin, 3.50 m. (Schriften aus "Theorie und Praxis der Schmelzschweissung.")

Iron and Steel Institute. Journal. Vol. 114, 764 pp. 1926; vol. 115, 1082 pp. 1927. The Institute, London.

The abstracts in this journal form the best existing guide to the current literature of ferrous metallurgy.

Jacquet, Alexis. Aciers, fers, fontes. Ed. 2, revised. Vol. 2, 242 pp. 1927. Dunod, Paris. 23fr.

Deals with manufacture of steel, considering the blast-furnace, and the various steel-making furnaces including the electric furnace. Vol. 1, published in 1923, deals with properties, tests, and treatment.

Kerpely, K. von. Siliziumstahl als Baustahl und Stahlformguss. 41 pp. 1927. Wilhelm Knapp, Halle a. S. 3.90m.

Krog, Frederick A. Lommebog for Jern—og Mellallstbere. 346 pp. 1926. Teknologisk Instituts Forlag, Copenhagen.

Lana Sarrate, C. Metalografia y tratamientos térmicos industriales de hierros y aceros. 382 pp. 1926. Casa Editorial Espasa-Calpe, Rio Rosas 24, Madrid.

Larsen, B. M., and Grodner, A. Certain Relations between Refractories Service, Insulation, and the Flow of Heat in the Open-Hearth Furnace. 20 pp. 1927. Carnegie Institute of Technology, Pittsburgh. 15 cents. (Mining and Metallurgical Investigations, Bulletin 32.)

Co-operative work with the U. S. Bureau of Mines.

Lipine, V. N. Metallurgy of Cast-Iron, Wrought-Iron, and Steel. Ed. 2, vol. 3, pt. 1. Electric Smelting. 376 pp. 1926. Leningrad.

Printed in Russian.

Manuel des laboratories sidérurgiques; methodes analytiques conventionnelles de la Communauté Arbed Terres-Rouges. 310 pp. 1927. Dunod, Paris. 30fr.80.

Concise presentation of analytical methods used by group of steel works in Luxemburg.

Moore, Herbert F. A Study of Fatigue Cracks in Car Axles; a Report of the Investigation Conducted by the Engineering Experiment Station, University of Illinois, in Co-operation with Utilities Co-operative Research Committee. 24 pp. 1927. University of Illinois, Urbana, Ill. 15 cents. (Engineering Experiment Station, Bulletin 165.)

Moore, Herbert Fisher, and Kommers, J. B. Fatigue of Metals, with Chapters on the Fatigue of Wood and of Concrete. 326 pp. 1927. McGraw-Hill Book Co., New York. $4.

Summary of the more important facts concerning the strength of metals under repeated stress, a brief review of the more important of the current theories of fatigue of metals and a description of apparatus and methods used in making an experimental study of the fatigue of metals.

Moore, H. F., Lyon, S. W., and Inglis, N. P. Tests of the Fatigue Strength of Cast Iron; a Report of an Investigation Conducted by the Engineering Experiment Station, University of Illinois, in Co-operation with the Allis-Chalmers Manufacturing Company. 50 pp. 1927. University of Illinois, Urbana, Ill. 30 cents. (Engineering Experiment Station, Bulletin 152.)

Müller-Hauff, Albert, and Stein, K. Autostähle des Welthandels. 195 pp. 1927. Verlag Stahleisen, Düsseldorf. 9m.

"The present book discusses the manufacture and properties of the special alloy steels used in the construction of automobiles. The use of such steels is becoming ever more extended, and whereas in former days the practice of maintaining secrecy concerning the processes of manufacture and treatment of such materials was followed, it is now recognized that there is no longer any advantage to be gained by concealment. Accordingly, the aim of the author has been to place the whole of his experience in the art of the manufacture and treatment of the materials on a clear basis, intelligible alike to the metallurgist who supplies the material and to the manufacturer who uses it in the construction of his machines." *Journal of the Iron and Steel Institute,* 1927.

Penton Publishing Company. Large Uses of Steel in Small Ways. Vol. 1, 63 pp. c 1926. The Company, Cleveland. $2.

Reprint of articles in "Iron Trade Review," 1923-1926. Describes briefly the manufacture of many steel products of small size or light construction.

Preger, E. Die Bearbeitung der Metalle in Maschinenfabriken durch Giessen, Schmieden, Schweissen, Härten und Tempern; unter Mitwirkung von P. Kampf und E. Saur. Ed. 8. 3 pts. 1926. Max Jänecke, Leipsic. 2.70m. each. (Bibliothek der gesamten Technik, vol. 339, 340, 341.)

Pt. 1—Die Werkstoffe; Formerei und Giesserei. 145 pp.

Pt. 2—Das Schmeiden und seine verwandten Arbeiten. Pp. 146-292.

Pt. 3—Schweissen, Härten und Tempern. Pp. 293-426.

Preuss, E. Praktische Nutzanwendung der Prüfung des Eisens durch Aetzverfahren und mit Hilfe des Mikroskopes. Ed. 3, 198 pp. 1927. Julius Springer, Berlin. 7.80m.

Pure Iron Era; a Magazine Devoted to Industrial Conservation and Development through the use of Ferrous Metals of Special Analysis. 1927. American Rolling Mill Co., Middletown, Ohio. $1 a year.

House organ. Issues bear no date except the year.

Schleicher, S. Verbrennungsvorgänge im Herdraum von Siemens-Martin-Öfen verschiedener Art. 1927. Verlog Stahleisen, Düsseldorf. 1.60m.

Schlipköter, Max. Wärmewirtschaft im Eisenhüttenwesen. 119 pp. 1926. T. Steinkopff, Dresden. 7m. (Wärmelehre und Wärmewirtschaft in Eingeldarstellungen, vol. 3.)

Schönfeld, H. Kritische Studien zum wirtschaftlichen Problem des Zwei- und Drieschichtensystems in Hochofenbetrieben. 87 pp. 1926. Gustav Fischer, Jena. 2.20m.

Schiefer, J., and Grün, E. Lehrgang der Härtetechnik. Ed. 3. 211 pp. 1927. Julius Springer, Berlin. 7.50m.

Hardening and tempering for toolmakers.

Spooner, Thomas. Properties and Testing of Magnetic Materials. 385 pp. 1927. McGraw-Hill Book Co., New York. $5.

Originally published in part in "Electric Journal." Primarily for the electrical designer. Deals with magnetic properties of plain and alloy steels, with magnetic testing, and with commercial applications.

Spring, La Verne Ward. Non-Technical Chats on Iron and Steel and Their Application to Modern Industry. Revised ed. 2. 465 pp. c 1927. F. A. Stokes Co., New York. $4.

Popular descriptive work. Constitutes an elementary outline, of value to beginners in the steel industry and of interest to general readers. Author is a steel-works chemist and his book though non-technical, is reliable.

Staffordshire Iron and Steel Institute. Proceedings Vol. 40, 116 pp.; vol. 41, 110 pp. 1927. The Institute, St. James Road, Dudley, England.

These two volumes, published together, cover the annual meetings of 1924-1925, and 1925-1926.

Sivyer Steel Casting Company. Alloy Steel Castings. 42 pp. c 1927. The Company, Milwaukee, Wis.

Trade literature, describing manufacture briefly and indicating physical properties.

Tafel, Wilhelm. Theory and Practice of Rolling Steel; translated by Richard Rimbach. 300 pp. 1927. Penton Publishing Co., Cleveland. $6.

Concerned primarily with the design of rolls—a subject on which few books are available in English.

Tapsell, H. J., and Clenshaw, W. J. Properties of Materials at High Temperatures. 1. Mechanical Properties of Armco Iron, 0.17 Per Cent Carbon Steel, and 0.24 Per Cent Carbon Steel with Special Reference to Creep. 60 pp. 1927. H. M. Stationery Office, London. 1sh. 9d. (England—Department of Scientific and Industrial Research. Engineering Research, Special Report 1.)

Traeger, L. Die Anlassvorgänge in abgeschrechten Kohlenstoffstählen. 20 pp. 1927. V. D. I. Verlag, Berlin. 3.80m.

Changes in length during annealing are compared with changes in other properties.

United Alloy Steel Corporation. Better Sheet Metal. Revised. 47 pp. 1926. The Corporation, Canton, Ohio.

"The story of a better sheet iron; its production and use with reference tables and specification data."

United States Steel Corporation. Methods of the Chemists of the United States Steel Corporation for the Sampling and Analysis of Gases. 187 pp. 1927. Carnegie Steel Co., Pittsburgh. $2.

This new edition deals fully with apparatus and methods but is much more than a manual of methods and therefore has an appeal wider than to the chemical laboratory. It presents much original information on sampling, analysis, measurement, and combustion of gases and is thus of value to combustion engineers and others interested in fuel economy.

Urquhart, J. W. Steel Thermal Treatment. 352 pp. 1927. Crosby Lockwood & Son, London. 21sh.

Weber, Andreas. Die natürliche und künstliche Alterung des gehärteten Stahles. 77 pp. 1926. Julius Springer, Berlin. 9m.

Physical and metallographic investigation of volume changes and other phenomena.

Wedding, H. Das Eisenhüttenwesen. Ed. 7, 134 pp. 1927. B. G. Teubner, Leipsic. 2m. (Aus Natur und Geisteswelt, vol. 20.)

Weston Concrete Engineering Company, Ltd. Correspondence between H. Weston and Ministry of Transport on the Relative Value of Mild Steel and High Tensile Steel in Reinforced Concrete Construction. 21 pp. n.d. The Company, London.

Correspondence and reports 1925-1926.

Economics, Statistics, Directories

American Iron and Steel Institute. Annual Statistical Report for 1926. 102 pp. 1927. The Institute, New York. $5.

Production, imports, exports and prices of iron and steel products for United States and Canada.

Appleton, John B. The Iron and Steel Industry of the Calumet District; a Study in Economic Geography. 133 pp. c 1927. University of Illinois, Urbana, Ill. $1.50. (Studies in the Social Sciences, vol. 13, No. 2, June, 1925.)

Davis, Hubert W. Iron Ore, Pig Iron, and Steel in 1926. Published October, 1927. Government Printing Office, Washington, D. C. 10 cents.

Advance publication of pp. 87-124 of the United States Bureau of Mines Mineral Resources of the United States, 1926, part 1. Review of industry and trade, with statistics.

Duluth and Iron Range Rail Road Company. Transportation of Iron Ore. 56 pp. 1927. The Company, Duluth.

Pamphlet without title page and with name of company given in several different forms. Outlines history and describes activities of this railroad.

Hardware Age Verified List of Wholesalers and Retailers. 1927. Hardware Age, New York. $12.

Jahrbuch und Adressbuch für die gesanite Draht-Industrie Deutschlands. First annual ed. 155 + 232 pp. 1927. Draht-Welt-Verlag, Hall a. S. 15m.

League of Nations. International Economic Conference, Geneva, May, 1927; Documentation; Memorandum on the Iron and Steel Industry. 133 pp. 1927. World Peace Foundation, Boston. $1.

Mainly statistical, dealing with economic, and labor conditions in various countries.

National Federation of Iron and Steel Manufacturers. Statistics of the Iron and Steel Industries (1925). 111 pp. 1927. The Federation, London. 5sh.

Schlenker, M. Die Eisen-Industrie in der Welt unter Berücksichtigung des internationalen Eisenpaktes. 34 pp. 1927. Gustav Fischer, Jena. 1.10m.

Sheet Steel Trade Extension Committee. 5000 Sheet Steel Products and Who Make Them. 445 pp. 1927. The Committee, Pittsburgh. $3.

Deals briefly with history, weights, gauges, and simplified dimensions; lists manufacturers of sheet-metal articles alphabetically, geographically, and classified by products.

A very useful directory.

Smith, Wilfred. A Geographical Study of Coal and Iron in China. 83 pp. 1926. Hodder & Stoughton, Ltd., London. 5sh.

Vanderblue, Homer Bews, and Crum, W. L. The Iron Industry in Prosperity and Depression. 193 pp. 1927. A. W. Shaw Company, Chicago. $7.50.

Published in part in "Iron Age" and "Harvard Business Review."

Valuable analysis, extending over a long period. Attempts to develop a statistical method of forecasting conditions in the iron and steel industry.

Foundry Practice

Dworzak, Hans, and Karzinsky, Hans. Lehr— und Hilfsbuch der Eisen- und Stahlgiesserei nebst einem Kurzen Abriss über Nichteisenmetalle (Metallgiesserei). 373 pp. 1927. Hölder-Pichler-Tempsky, Vienna. 10m.

Kothny, Erdmann. Gesunder Guss; Eine Anleitung für Konstrukteure und Giesser, Fehlguss zu verhindern. 70 pp. 1927. Julius Springer, Berlin. 1.80m.

Escher, Max. Das Formen und Giessen von Metallen, Eisen und Stahl. 400 pp. 1926. Dieck & Co., Stuttgart. 7.70m.

Fabart, A. E. Manuel du fondeur. 416 pp. 1926. J. B. Baillière et Fils, Paris. 25fr. (Bibliotheque professionnelle.)

Geiger, C. ed. Handbuch der Eisen— und Stahlgiesserei. Ed. 2. Vol. 2. Formen und Giessen; by C. Irresberger. 584 pp. 1927. Julius Springer, Berlin. 57m.

Vol. 1 of this edition was published in 1925.

Hermanns, Hubert. Taschenbuch für Hütten— und Giessereileute. Ed. 2. 392 pp. 1927. Wilhelm Knapp, Halle a. S. 8.50m.

Hoffmeister, K. Die Förderkosten in Eisengiessereien. 60 pp. 1926. A. Ziemsen, Wittenberg. 3m.

Masviel, J. La technique du modèle de fonderie. 230 pp. 1927. Dunod, Paris. 53fr.

Principles and practice of making foundry patterns in various materials.

Der Spritzguss und seine Anwendung 40 pp. Beuth-Verlag, Berlin. 1.50m.

Stöpel, H. Rechnen für Former und Giesser. 174 pp. Oskar Leiner, Leipsic. 2.30m.

A text-book for industrial schools.

Weber, H., and Hermanns, H. Die Gussrohren-Herstellung in der festen Form und in der Schleuderform. 68 pp. 1927. Wilhelm Knapp, Halle a. S. 4.50m.

Corrosion, Protective Coatings

American Rolling Mill Company. Galvanized Iron for Roofs and Roof Drainage. 56 pp. 1926. The Company, Middletown, Ohio.

General information, suggested specifications, tables of loads for various types of roof, and characteristics of "Armco" ingot iron.

American Society for Testing Materials. Report of Committee A-5 on Corrosion of Iron and Steel. 72 pp. 1927. The Society, Philadelphia. 75 cents.

Bablik, Heinz. La galvanisation du fer; galvanisation a chaud, galvanisation électrolytique, Sherardisation, galvanisation par projection; translated by A. Schubert. 220 pp. Dunod, Paris.

Byers (A. M.) Company. Corrosion of Wrought Iron, Cast Iron and Steel Pipe in House Drainage Systems. 32 pp. 1927. The Company, Pittsburgh.

Reprints of two papers—one by W. P. Gerhard before the American Society of Mechanical Engineers in 1918, and one by T. J. Claffy before the eleventh annual meeting of the American Society of Sanitary Engineering.

Evans, Ulick R. Corrosion of Metals. Ed. 2. 259 pp. 1926. Edward Arnold & Co., London. 15sh.

Revision of 1924 edition with considerable new material.

Kluytmans, C. La Galvanisation a chaud. L'Usine, Paris. 20fr.

Lettre, G. de. Protection des métaux contre la corrosion. 208 pp. L'Usine, Paris. 34fr.

Snodgrass, Robert D. Copper Bearing Steel Resists Corrosion. 15 pp. 1926. Truscon Steel Company, Youngstown, Ohio.

Compilation of results of tests by various investigators.

UNITED STATES GOVERNMENT PUBLICATIONS

The publications listed below may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C.

UNITED STATES BUREAU OF FOREIGN AND DOMESTIC COMMERCE

Trade Information Bulletins

No. 470. Iron and Steel Trade and Industry of the Netherlands, by Jesse F. Van Wickel and J. Joseph W. Palmer. 17 pp. 1927. 10 cents.

No. 484. Origin and Development of the Continental Steel Entente, by J. Joseph W. Palmer. 45 pp. 1927. 10 cents.

UNITED STATES BUREAU OF MINES

Bulletins

No. 239. Iron-Ore (Hematite) Mining Practice in the Birmingham District, Ala., by W. R. Crane. 144 pp. 1927. 40 cents.

No. 270. Production of Sponge Iron, by C. E. Williams, E. P. Bassett, and B. M. Larsen. 175 pp. 1927. 35 cents.

No. 278. Magnetic Concentration of Iron Ores of Alabama, by Oscar Lee, B. W. Gandrid, and F. D. De Vaney. 75 pp. 1927. 20 cents.

Technical Papers

No. 391. Iron Blast-Furnace Reactions, by S. P. Kinney, P. H. Royster, and T. L. Joseph. 65 pp. 1927. 15 cents.

No. 401. Blast-Furnace Gas Studies, by J. F. Barkley. 9 pp. 1927. 5 cents.

No. 407. Development, Mining, and Handling of Ore in Folded and Faulted Areas, Red Iron Ore Mines, Birmingham District, Alabama.

UNITED STATES BUREAU OF STANDARDS

Scientific Papers

No. 545. Determination of the Magnetic Induction in Sheet Steel, by Raymond L. Sanford and James M. Barry. 727-742 pp. 1927. 10 cents.

No. 562. Density of Hot-Rolled and Heat-Treated Carbon Steels, by H. C. Cross and E. E. Hill. 451-466 pp. 1927. 10 cents.

Simplified Practice Recommendations

No. 18. Builders' Hardware; Effective Date May 1, 1927. 72 pp. 1927. 10 cents.

(Continued on page 33)

Electric Drives in the Steel Rolling Mills

A Review of Important Installations on Continuous and Reversing Mills, Together with a Discussion Regarding the Use of Synchronous Motors

By A. F. KENYON*

RECENT developments in electrical drives for steel rolling mills have been along the lines of improvement and simplification of existing designs, rather than in the development and utilization of radically new ideas. Modern mills are exacting in their requirements, and mill operators appreciate the important part played by the electrical drive and automatic control in the successful and economical operation of any modern rolling mill unit.

The past year has not been marked by the installation of an unusually large number of new drives, although a number of quite important new mills have been contracted for. The accompanying tabulation lists the main roll drive motors of 300 hp. and greater capacity which have been sold by one manufacturer from December 1, 1926 to December 1, 1927.

A. F. KENYON

Continuous Mills

Mills for the continuous rolling of steel have been noted for their economy of labor costs and high tonnage output of specialized products. The older types of continuous mills, in which all stands were driven from a layshaft by bevel gears, were admirably suited to rolling a narrow range of semi-finished product sizes, but were entirely too inflexible to permit the production of the wide range of finished sizes required of all but the most specialized mills. In recent years, this inflexibility has been done away with by the use of separate adjustable speed motors on each of the several finishing stands, thus permitting individual adjustment of roll speeds and allowing wide latitude in the making up of rolling schedules. The success of these so-called "tandem" mills depends very largely on the electrical equipment, for the even flow of steel through the successive stands, without excessive looping or stretching, can be accomplished only if the control is such that speed adjustments can be quickly and easily made and accurately maintained. Practice has shown the direct current adjustable speed motor to be ideally suited for the drive of such mills.

At the Gary plant of the American Sheet and Tinplate Company there was placed in service during November a new 16-in. continuous mill for the production of long lengths of wide strip material. The intermediate and finishing stands are of the four-high type, using large backing-up rolls in roller bearings to support the small working rolls. The first edging stand is driven by a 350 hp. induction motor, the four roughing stands by two 1800 hp. induction motors, and each of the two intermediate and four finishing stands is driven by a separate 2500 hp., 160/320 rpm., 600 v. d.c. motor. The d.c. motors are of the compensated type, indirectly compounded by small series exciters. The series and shunt field rheostats are mechanically connected so that they operate together and steps of resistance so proportioned that very close speed regulation is obtained at all speed settings. On the manufacturer's test floor the speed at twice full load was only one revolution per minute below the no-load speed, at all speeds between 160 and 320 rpm. This is quite remarkable, and probably represents much better performance than is required by the average tandem mill, even though operating at high delivery speeds.

Power for the six 2500 hp. motors is supplied by three 3000 kw. motor generator sets, each consisting of two 1500 kw. 600 v. generators, and a 4300 hp., 80 per cent power factor, three-phase, 25-cycle, 2200 v. synchronous motor. The d.c. motors are started by generator voltage control, while control of the speed over the operating range is by means of motor field adjustment. All operations required in connecting the motors and generators to the bus, building up generator voltage, and individual speed adjustment of each motor, are controlled from a steel panel pulpit desk, mounted in a balcony overlooking the mill. In the motor room, a switchboard of nearly 100 panels and more than 200 feet long is provided to control the motor generator sets, auxiliary feeders, transformers, etc., and to mount the automatic equipment which is controlled from the pulpit desk.

The American Rolling Mill Company at Middletown, Ohio, are now installing a continuous hot strip mill, capable of producing strip material in exceptionally wide widths and long lengths from slabs up to 6 in. thick. A unique feature of the mill is the individual motor drive for each of the 11 mill stands, giving unusual flexibility, and assuring almost uninterrupted operation, as rolling can continue with one disabled unit by dividing the reduction among the remaining stands. Spacing of the stands is such that the pieces run out after the first four passes, and these stands are therefore to be driven by constant speed induction motors, with slip regulator secondary control to effectively utilize the flywheel effect incorporated in the drives.

---

*General engineer, Westinghouse Electric & Mfg. Co.

These motors are of 600, 800, 1000 and 1200 hp. capacity, respectively. Succeeding stands of the mill are closely spaced, and the steel strip may be in two or more stands simultaneously, so that d.c. adjustable speed motors are used to drive the last seven stands. Motors for stands 5, 6 and 7 are of 2000 hp., 300/500 rpm., 600 v. rating, and for stands 8, 9, 10 and 11 are of 3000 hp., 180/360 rpm., 600 v. rating. Magnetic starters are provided for each of the d.c. motors.

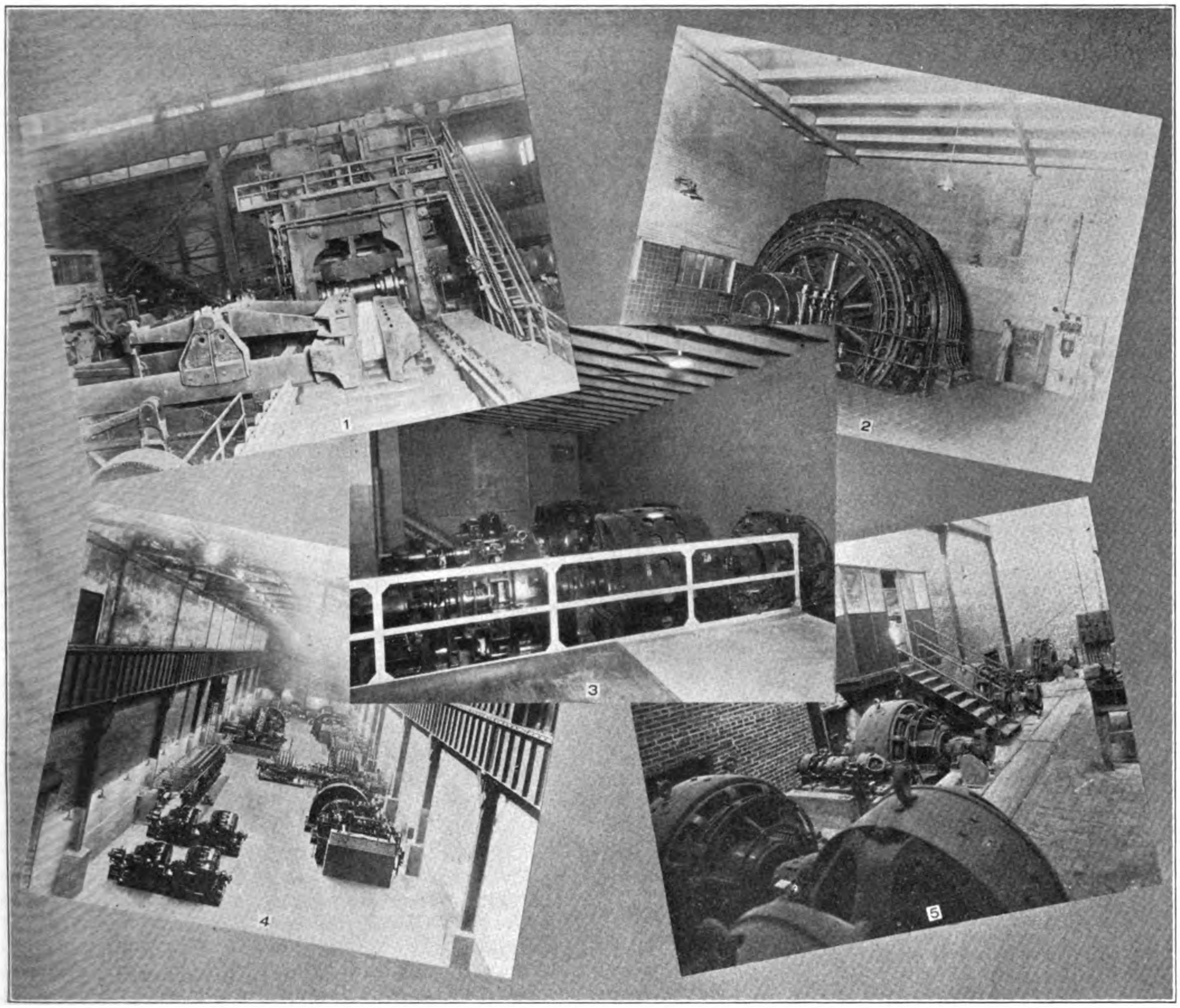


FIG. 1—54 in. reversing blooming mill at the Homestead Works of the Carnegie Steel Company. This mill is driven by the 8,000 hp. reversing motor. FIG. 2—8,000 hp., 700 volt, 40/80 rpm., single unit reversing motor driving a 54-in. blooming mill at the Homestead Works of the Carnegie Steel Company. FIG. 3—Two 2,500 kw., 600 volt d.c., synchronous motor generator sets supplying power to merchant mill motors at the Corrigan-McKinney Steel Company. FIG. 4—Structural mill motor room at the Homestead Works of the Carnegie Steel Company. FIG. 5—Two 720 hp., and two 600 hp. d.c. adjustable speed motors driving the four finishing stands of the 10 in. tandem hot strip mill of the Laclede Steel Company at Alton, Ill.

This plant now generates its own 2200 v. 25-cycle power, but an analysis of all factors showed advantages in the use of 60-cycle central station power. The new strip mill is therefore being installed to operate on 6600 v., 60-cycle, three-phase power, supplied from a stepdown transformer substation located on the steel plant premises.

Direct current power at 600 v. for the operation of the seven large d.c. motors will be furnished by three 4000 kw. motor generator sets, each consisting of two 2000 kw., 600 v. generators, and a 5800 hp., 85 per cent power factor, three-phase, 60-cycle, 6600 v. synchronous motor. Excitation for the machines of these sets, and for the seven d.c. motors will be supplied by a 300 kw., 250 v. motor generator set, and auxiliary 250 v. power for cranes and mill auxiliaries will be supplied by two 750 kw., synchronous motor generator sets. The control provides an emergency tie connection between the

MILL DRIVE MOTORS ABOVE 300 H. P. FURNISHED BY W. E. & M. COMPANY, DEC. 1, 1926 TO DEC. 1, 1927

No.	Company.	Location.	Mill.	Drive.	H. P.	R. P. M.	Voltage.	Cycles.
1.	Alan Wood Iron & Steel Co.	Conschohocken, Pa.	Sheet Jobbing	Geared	600	295	2200	25
2.	American Rolling Mill Co.	Ashland, Ky.	Bar Plate	Geared	500	585	2200	60
3.	American Rolling Mill Co.	Ashland, Ky.	Sheet Jobbing	Geared	3000	505	6600	60
4.	American Rolling Mill Co.	Ashland, Ky.	Cold Strip	Geared	600	400/800	230	d.c.
5.	American Rolling Mill Co.	Ashland, Ky.	Cold Strip	Geared	600	400/800	230	d.c.
6.	American Rolling Mill Co.	Ashland, Ky.	Cold Strip	Geared	600	400/800	230	d.c.
7.	American Rolling Mill Co.	Ashland, Ky.	Cold Strip	Geared	600	400/800	230	d.c.
8.	American Rolling Mill Co.	Ashland, Ky.	Cold Strip	Geared	600	400/800	230	d.c.
9.	American Rolling Mill Co.	Middletown, Ohio.	Sheet	Geared	1200	244	2200	25
10.	American Rolling Mill Co.	Middletown, Ohio.	Sheet	Geared	1200	244	2200	25
11.	American Rolling Mill Co.	Middletown, Ohio.	Bar Plate	Geared	800	505	6600	60
12.	American Rolling Mill Co.	Middletown, Ohio.	Bar Plate	Geared	800	505	6600	60
13.	American Rolling Mill Co.	Middletown, Ohio.	Bar Plate	Geared	1000	585	6600	60
14.	American Rolling Mill Co.	Middletown, Ohio.	Bar Plate	Geared	1200	705	6600	60
15.	American Rolling Mill Co.	Middletown, Ohio.	Bar Plate	Geared	2000	300/500	600	d.c.
16.	American Rolling Mill Co.	Middletown, Ohio.	Bar Plate	Geared	2000	300/500	600	d.c.
17.	American Rolling Mill Co.	Middletown, Ohio.	Bar Plate	Geared	2000	300/500	600	d.c.
18.	American Rolling Mill Co.	Middletown, Ohio.	Hot Strip	Geared	3000	180/360	600	d.c.
19.	American Rolling Mill Co.	Middletown, Ohio.	Hot Strip	Geared	3000	180/360	600	d.c.
20.	American Rolling Mill Co.	Middletown, Ohio.	Hot Strip	Geared	3000	180/360	600	d.c.
21.	American Rolling Mill Co.	Middletown, Ohio.	Hot Strip	Geared	3000	180/360	600	d.c.
22.	American Rolling Mill Co.	Zanesville, Ohio.	Cold Sheet	Geared	400	514	2200	60
23.	American Sheet & Tinplate Co.	Gary, Ind.	16-in. Strip	Geared	2500	160/320	600	d.c.
24.	American Sheet & Tinplate Co.	Gary, Ind.	16-in. Strip	Geared	2500	160/320	600	d.c.
25.	American Sheet & Tinplate Co.	Gary, Ind.	16-in. Strip	Geared	2500	160/320	600	d.c.
26.	American Sheet & Tinplate Co.	Gary, Ind.	16-in. Strip	Geared	2500	160/320	600	d.c.
27.	American Sheet & Tinplate Co.	Gary, Ind.	16-in. Strip	Geared	2500	160/320	600	d.c.
28.	American Sheet & Tinplate Co.	Gary, Ind.	16-in. Strip	Geared	2500	160/320	600	d.c.
29.	American Steel & Wire Co.	Worcester, Mass.	10-in. Rod	Geared	2000	230/460	600	d.c.
30.	American Steel & Wire Co.	Worcester, Mass.	10-in. Rod	Direct	800	140/510	600	d.c.
31.	American Steel & Wire Co.	Worcester, Mass.	10-in. Rod	Direct	800	140/510	600	d.c.
32.	Babcock & Wilcox Co.	Beaver Falls, Pa.	Seamless Tube	Direct	300	175/350	230	d.c.
33.	Babcock & Wilcox Co.	Beaver Falls, Pa.	Seamless Tube	Direct	300	175/350	230	d.c.
34.	Carnegie Steel Co.	Farrell, Pa.	24-in. Continuous Billet	Geared	4000	450	2200	60
35.	Copperweld Steel Co.	Glassport, Pa.	14-in. Merchant	Geared	850	514	2200	60
36.	Ford Motor Co.	Detroit, Mich.	10-in. Merchant	Geared	800	200/600	500	d.c.
37.	Ford Motor Co.	Detroit, Mich.	10-in. Merchant	Direct	1250	300/550	500	d.c.
38.	Ford Motor Co.	Detroit, Mich.	10-in. Merchant	Direct	2000	137/275	500	d.c.
39.	Illinois Steel Co.	South Chicago, Ill.	35-in. Blooming	Direct	6500	60/140	700	d.c.
40.	Jones & Laughlin Steel Co.	Woodlawn, Pa.	30-in. Reversing Bar	Direct	3000	65/130	650	d.c.
41.	National Tube Co.	Lorain, Ohio.	30-in. Reversing Bar	Direct	3000	65/130	650	d.c.
42.	Newton Steel Co.	Newton Falls, Ohio.	Cold Strip	Geared	500	400/800	230	d.c.
43.	Pollak Steel Co.	Marion, Ohio.	Rail Rerolling	Geared	600	705	2200	60
44.	Timken Roller Bearing Co.	Canton, Ohio.	Seamless Tube	Geared	350	350	2200	60
45.	Washburn Wire Co.	Phillipsdale, R. I.	10-in. Rod	Direct	850	250/500	230	d.c.
46.	Washburn Wire Co.	Phillipsdale, R. I.	10-in. Rod	Direct	300	300/650	230	d.c.
47.	Washburn Wire Co.	Phillipsdale, R. I.	10-in. Rod	Direct	300	300/650	230	d.c.
48.	Youngstown Sheet & Tube Co.	Youngstown, Ohio.	Seamless Tube	Geared	450	720	2200	60

Total, Direct Current	33 units.	58,700 hp.
Total, Induction	11 units.	11,250 hp.
Total, Synchronous	4 units.	5,700 hp.
Grand Total	48 units.	75,650 hp.

excitation and main 250 v. buses so that accident to the exciter set will not shut down the mill.

The mill layout, requiring separate control pulpits for the roughing and finishing sections of the mill, and the further possibility that 600 v. power will be required from this motor generator set substation for future adjacent mills, made starting by generator voltage control inadvisable, due to the extra complication caused by the number of parallel control points. Magnetic starters were therefore provided for each of the d.c. motors. By this means the pulpit control is made very simple, and an operator of very little electrical experience can be employed.

About the middle of the year, the revamped 10-in. strip mill of the Laclede Steel Company, at Alton, Ill., was placed in service. The looping finishing train was replaced by five modern four-high, roller bearing stands in tandem, with individual d.c. motors on the four finishing stands, and a fifth larger 1500 hp. d.c. motor installed to drive the six-stand continuous roughing and intermediate mill. With the new layout, billets up to 30 ft. long may be rolled, and the finished strip, in widths up to 8 in., either coiled directly from the last stand, or cut by a rotary flying shear to lengths which may be handled on a notched hotbed. Thin narrow strip may be finished at delivery speeds up to 2800 ft. per minute.

Until quite recently, rod mills followed the conventional Garrett looping mill design, or the Morgan continuous layout, and constant speed drives were very generally used. Such mills were not adapted to the production of more than a few sizes of product, and some difficulty was also experienced in rolling the several strands in the same sets of rolls. Modern layouts therefore divide the mill into two or more groups of stands, each group having an adjustable speed drive, so that considerable flexibility is obtained, and the mill enabled to roll a variety of products. In other mills, individual control of the finish rolling of each strand is secured by dividing the finishing mill into two duplicate sections, so that after the roughing passes are made double strand, one strand may be finished in one side of the mill, and the other strand finished in the second set of finishing rolls.

Examples of the trend toward adjustable speed drives for rod mills are the mill at Worcester, placed in service during the past summer and having one 3000 hp. and two 800 hp. d.c. driving motors, and a second similar mill at the same plant, for which a 2000 hp., 230/460 rpm., and two 800 hp., 140/510 rpm., 600 v. motors have been ordered.

Reversing Mills

Of particular interest is the group of reversing motor drives on the new structural mills at the Homestead works of the Carnegie Steel Company, installation of which was completed during the year. The installation includes seven reversing motors having a total combined continuous rated capacity of 38,000 hp. The 54-in. blooming mill motor is rated 8000 hp., 40/80 rpm., 700 v., with a rated emergency torgue capacity of 2,500,000 lbs. at 1 ft. radius. In actual service this motor has developed torques in excess of 3,000,000 lb.-ft. This is the largest single unit d.c. machine yet built and is applied to drive one of the heaviest blooming mills yet laid down.

Also of considerable interest are the drives for the 52-in. roughing and intermediate universal structural mills. In order to roll the new line of wide flange beam sections, each of these mills has three sets of rolls, all working on the steel simultaneously. Reductions in the main horizontal and vertical rolls may be 30 per cent or more, while reductions in the edging rolls are usually light. It is thus apparent that when passing from the edging to the main mill rolls, the speed of the main rolls must exceed that of the edging rolls, due to the reduction being taken in the main rolls. When passing in the opposite direction, the speed of the edging rolls must be slightly greater than that of the main rolls. It was thus necessary to apply separate reversing motors to the main and edging rolls and to arrange to control so that the speed relations could be made and maintained at the proper value, depending on the reduction and direction of rotation, for each pass. Also it was of the utmost importance that the screwdown settings of the three sets of rolls be made quickly and accurately for each pass. After due consideration of the problems involved, it was decided to accomplish the relative speed settings of the 7000 hp. main and 2000 hp. edging roll motors, and the screwdown settings, automatically, the settings having been previously determined by calculation and set up on the automatic panels. With the control as worked out and installed, all settings for a particular rolling schedule are set up on a suitable plug-in board, and in operation a multi-point master switch is advanced one position after each pass. This master switch closes the appropriate circuits so that the relative speeds of the two motors are set for the draft to be taken, and the three screwdowns are automatically advanced to the predetermined positions for the next pass. With this automatic control, one man is easily able to control the entire mill. Settings are made accurately and in the minimum of time, assuring uniformity of product and maximum tonnage output.

The Jones & Laughlin Steel Company at Woodlawn, Pa., and the National Tube Company at Lorain, O., have each installed new reversing bar mills to supply round billets for seamless tube mills. A 3000 hp., 650 v., 65/130 rpm. reversing motor was applied in each case. Instead of the induction motor driven flywheel motor generator set usually associated with a reversing mill drive, power for the motor at Woodlawn is supplied from a synchronous motor generator set. The entire peak load of each pass is thus transmitted through the set to the power system, but where the system is large compared to the capacity of the mill drive, this may not be objectionable, and be more than offset by the advantage of power factor correction, large air gap, and elimination of the heavy flywheel.

A 6500 hp., 700 v., 60/140 rpm., reversing motor, together with a 6000 kw. flywheel motor generator set, has been sold to the Illinois Steel Company, South Chicago, Ill., for the electrification of their 35-in. blooming mill. This mill is engaged in the heavy tonnage production of small section blooms and billets, and a large capacity motor with comparatively high full field speed is required to give the torques and acceleration rates necessary for rapid operation and heavy tonnage production.

Previous blooming mill monthly tonnage records were exceeded in March, 1927, when the 40-in. electrically driven blooming mill at the Inland Steel Company produced 90,879 gross tons of blooms from 104,450 gross tons of ingots, exceeding its own record of the year before by about 15 per cent.

Synchronous Motors

The desire for improved power factor has caused consideration to be given to synchronous motors for rolling mill drives. In cases where starting conditions are not too severe, where adjustable speed is not required, and where mill load peaks can be handled without flywheels, synchronous motors find many sound applications. Without doubt, synchronous motors will be increasingly applied to rolling mills during the next few years, as their merits become more widely known.

A 4000 hp., 100 per cent power factor, three-phase 60-cycle, 2200 v., 450 rpm. synchronous motor is being installed to replace a steam engine on a 24-in. continuous billet and bar roughing mill, at the Farrell works of the Carnegie Steel Company. The power generating station at this plant is of only about 5000 kw. capacity, yet by careful design of the large mill motor the starting torque per ampere input will be made sufficiently high to easily start the mill without imposing excessive starting peaks of the small generating station.

In general it may be said that synchronous motors are not well suited to the driving of cold roll sheet mills, as such mills require starting torques of as much as twice the normal running torque, and also require pull-in torque nearly equal to the normal running torque. These torques can be obtained by starting the motor on full line voltage, and if the resulting current inrush is not objectionable to the power system, such applications may be made. At the Zanesville plant of the American Rolling Mill Company, some power factor correction was desired, and a 400 hp., 514 rpm., 80 per cent power factor synchronous motor has been applied to a cold roll mill. The motor is designed to start on full line voltage, developing 225 per cent starting torque and 115 per cent pull-in torque with a starting inrush of approximately 500 per cent normal. This motor has been in service for several months, and is operating very satisfactorily.

Employes Purchase Bonds

Twenty-seven thousand, or 42 per cent of the employes of the General Electric Company in its service for six months or more, are holders of about $30,000,000 worth (face value) of G. E. Employes' Securities Corporation bonds, an average of approximately $1,000 per person, according to a statement made public by J. R. Lovejoy, president of the corporation.

The By-Product Coke and Gas Industry

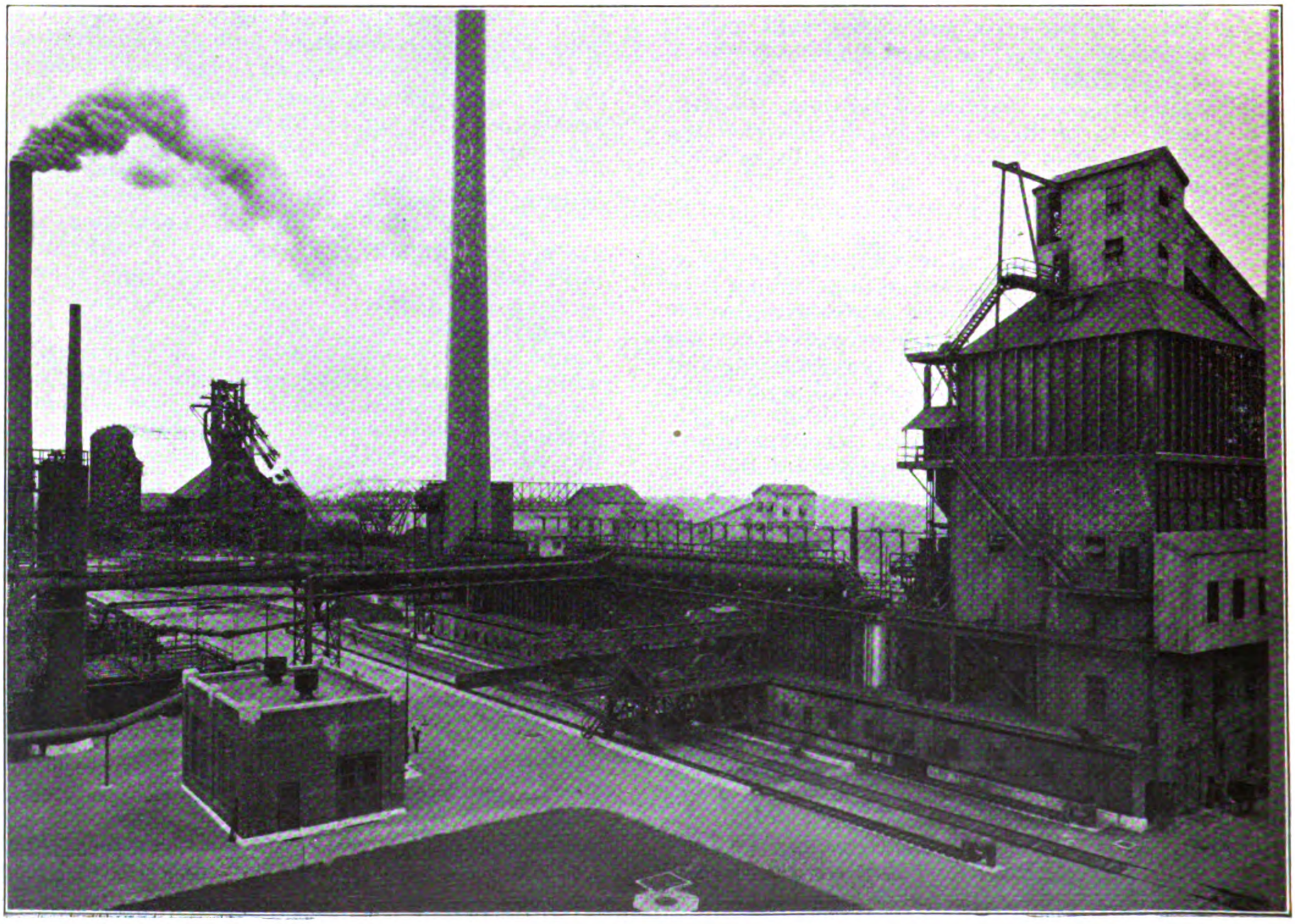
Heating Ovens with Blast Furnace Gas Becomes a Feature of Operation Which Will Undoubtedly Find Extensive Use —Elimination of Sulphur in Gas Advantageous

By C. J. RAMSBURG*

DURING 1927, new by-product coke plants with an annual coke productive capacity of over 5,000,000 tons were placed under construction or in operation in America. The steel industry, public utility, alkali, manufacturing and automotive industries were all represented in this increased capacity, as well as merchant companies serving these industries and the general public.

An exceedingly important development taking place during the year was the decision on the part of the By-Products Coke Corporation of Chicago to put in the necessary auxiliary equipment for using blast furnace gas on their Becker oven batteries, releasing approximately 12,000,000 cu. ft. of coke oven gas per day for use in Chicago by the gas industry. This method of heating has also been adopted by the Youngstown Sheet & Tube Company for under firing gas to be used in connection with their new plant at South Chicago. In the first case, the wisdom of building a type of battery which could eventually be operated with blast furnace gas has been demonstrated. All Becker ovens have this convertible feature. The wisdom of this provision for future change of plan has been further exemplified by the installation at the Lackawanna steel plant of the Bethlehem Steel Corporation. At this plant Koppers producers have been added to provide the underfiring gas. This gas is secured by using in the producer small coke removed from the furnace coke (greatly to its benefit) and coke breeze.

Both of these developments have been advocated by American coke oven engineers for a considerable period and it is gratifying to see these concrete developments. In Germany the use of blast furnace gas in oven heating has been in use for a long time with marked success. The realization in American practice of this important principle is bound to be an important development in many plants in the immediate future. Blast furnace gas has but a heating value of from 90 to 95 Btu. per cu. ft., and due to the large quality of inerts is difficult to use with anything but very low efficiency. Blast furnace gas has many poor qualities. For example, it may not be transported for any considerable



By-Product plant of the Central Alloy Steel Corporation distance except at large expense; flame temperatures are low and regeneration costly in most instances. On the other hand, due to the regeneration principle as applied in Becker ovens and in Koppers ovens of the combination type, the use of this gas can be effected with very high efficiency, and with such regeneration the flame temperature characteristics are beneficial rather than detrimental.

---

*Vice President, The Koppers Company, Pittsburgh, Pa.

There has been considerable interest among steel companies in freeing from sulphur the coke oven gas used for open-hearth heating. In the case of an open-hearth furnace the practical result of such purification is not merely to have the steel bath not gain sulphur but actually to lose it. This is by virtue of the ability of sulphur free gas to extract sulphur from the slag which, in turn, extracts sulphur from the steel bath. The Central Alloy Steel Corporation has in operation at its new plant at Massillon, Ohio, a liquid purification plant to accomplish this desirable sulphur removal.

This is the second instance that liquid purification has been used by steel companies, the first plant being that of the Pittsburgh Crucible Steel Company at Midland, Pa.

	No. of ovens	Est. annual coal carbonizing cap. tons
Completed in 1927.		
Alabama By-Products Corp.,Birmingham,Ala.	49	500,000
*Battle Creek Gas Co., Battle Creek, Mich.	7	35,000
Bethlehem Steel Co., Johnstown, Pa.	77	570,000
Bethlehem Steel Co., Lackawanna, N. Y.	57	520,125
Carnegie Steel Co., Clairton, Pa.	348	3,887,250
Central Alloy Steel Co., Massillon, O.	49	438,000
Consumers Power Co., Flint, Mich.	29	135,500
Diamond Alkali Co., Painesville, O.	23	227 030
Michigan Alkali Co., Wyandotte, Mich.	39	350,000
*Trumbull Cliffs Furnace Co., Warren, O.	17	162,000
West Boston Gas Co., Framingham, Mass.	15	47,523
Under Construction at Dec. 31, 1927.		
Columbia Steel Corp., Provo, Utah	23	223 000
Connecticut Coke Co., New Haven, Conn.	61	550 000
Hamilton Coke & Iron Co., Hamilton, O.	45	416 000
North Shore Coke&Chem. Co., Waukegan, Ill.	31	165,000
Tenn. Coal, Iron & R. R. Co., Fairfield, Ala.	63	657,000
Youngstown Sheet & Tube Co.,So.Chicago,Ill.	70	740 000
Zenith Furnace Co., Duluth, Minn.	41	350,000

*Addition to plant.

Ingot Mold Life and Chemical Analysis

In Order that Ingot Molds May Give the Greatest Return the Chemical Composition and Temperature of the Iron Must be Within Specified Limits

By E. H. WILLIAMS*

MOST ingot molds used by steel plants in the United States are ordinary grey iron castings and nearly all of them are made from so-called Bessemer pig iron, otherwise, pig iron of a chemical analysis to be used for the making of Bessemer steel.

A little history less than 30 years old on the steel processes in the United States will throw a little light on the reason for the selection of Bessemer iron for the production of ingot molds. Thirty years ago or less practically all the steel in this country was made by the Bessemer process and in order that the molds when unfit for use could be utilized as raw material for the steel making process, they were made of Bessemer iron, being remelted in a cupola along with pig iron, as at this time there were no mixers and the melting operation for the converter was carried out in a cupola. The first commercial production of ingot molds on a large scale by an independent mold company was undertaken in the Shenango Valley and at this time most of the so-called independent merchant blast furnaces in the Mahoning and Shenango Valleys were engaged in the production of Bessemer pig iron for the large steel companies, of which the Carnegie Company was the leader. This led quite naturally to the employment of Bessemer pig iron in ingot mold manufacture. The chemical specifications for Bessemer pig iron at this time were as follows:

Silicon	1.00 to 2.00
Sulphur	under .05
Phos.	under .10

No mention was made of manganese as it was fairly constant between .50 and .80 and was fixed by the use of Lake Superior Bessemer ores which did not vary. All ingot molds at this time were produced from metal in a cupola and due to a cupola loss of perhaps 20 points in silicon the Bessemer iron for molds was specified to run in the neighborhood of 1.50 in that element. Molds were produced in this manner for a great many years. The next change in their method of production was the use of direct metal from a blast furnace and the chemical specifications for this iron ran practically the same as above. During the past six or eight years a good deal of experimenting has been done and records have been kept of the behavior of molds made from iron varying in silicon from about one per cent to about two per cent and varying in manganese from .50 to about 1.50. At the present time I think if any mold maker was asked to designate an ideal analysis for standard molds, about 20 in. x 22 in., he would say something like this:

Silicon	1.75
Sulphur	as low as possible
Phos.	around .10
Mn.	.80 to 1.00

Practical results have not shown much variation in ingot mold life with the silicon and manganese varying within limits of the above experiments. It has however been determined that phosphorus up to .15 and possibly somewhat higher than this does not shorten the life of a mold and with most steel being made by the Bessemer process this amount of phos-

---

***President, The Vulcan Mold and Iron Co., Latrobe, Pa.**

phorus does not interfere with the use of the mold for subsequent use as raw material for steel making.

All of the above can be summed up by saying that within the ordinary commercial chemical specifications for Bessemer and malleable iron that most pig irons can be used for the production of good molds if the iron is physically right and the molds properly made.

An ingot mold is a dry sand casting; to be good, both the cheek and core must be well and uniformly rammed, carefully blackened with a refractory blacking, thoroughly well dried, carefully assembled, and cast with an iron that is physically right and at the proper pouring temperature; this being the point at which shrinkage will not occur, no cooler. The most important manufacturing operation is the drying. Poorly dried molds will not make good castings. The next important point is to have the metal "right" and manufacturers who use cupola metal have an advantage over the direct metal mold maker for the obvious reason that they can control their temperature. The relation therefore of ingot mold analysis to ingot mold life is not very definite within the commercial variations in analysis of so-called ingot mold iron which I should term was a low phosphorus malleable. However the relation of ingot mold life to care in manufacture and to proper pouring conditions of metal is very definite and very important.

Mold Failure

There is a possibility however that a radical change in chemical analysis from those given above may produce a change in mold life. It is well in considering this possibility to analyze the conditions governing mold failure. The normal failure of an ingot mold is due to fire cracking or heat checking. Other causes due to faulty design or poor steel plant practice are cracking or splitting, warping, and burning by the stream of steel. Fire cracking has been definitely traced to the growth of the iron under alternate heating and cooling. A number of theories have been advanced to account for growth of cast iron of which the following seems the most plausible. Inasmuch as the coefficient of expansion of iron is higher than graphite a cavity will result between the graphite flake and the iron matrix when a piece of cast iron is heated. This allows oxygen to penetrate which oxidizes the iron or its metalloids or is dissolved by the graphite. An increase in volume is thus caused which results in a permanent growth, when the casting cools to its original temperature. Each succeeding heating and cooling, as is the case with an ingot mold, increases the growth still further developing first as a fine microscopic crack on the surface and then more and more rapidly opens up into the so-called fire cracks. Growth may be retarded in several ways:

a—Reducing the size of the graphite flake thus minimizing the effect of the difference in coefficient of expansion.

b—More uniform distribution of the graphite.

c—Change in form of the graphite flake from a flat flake to a very fine curved lamellae or of round nodules.

d—Strengthening the matrix and making it more uniform.

Special Iron Mixture

These properties have been obtained through the manufacture of a special iron mixture on which patents are pending. By the use of from 40 to 60 per cent of steel in the cupola a metal is made having a total carbon content of about 3 per cent. The silicon is also lowered to about 1.25. The temperature of melting this special iron is kept as high as possible as it is thought that this reduces the size of the graphite flakes considerably. The theory back of this, developed by Professor Dr. H. Hanneman is that if the melting temperature exceeds 2730 deg. F. all the graphite is dissolved and in cooling no graphite nuclei or germs are present to aid the precipitation. Consequently when the precipitation takes place at about 2000 deg. F. the graphite which forms is in a finely divided state. The special iron produced in this manner and cast in ingot mold sections of about 2 in. or over has very unusual properties. It has a light grey fracture; the graphite is in very small, finely divided and uniformly distributed flakes; the matrix is entirely pearlitic or nearly so and the physical properties are about double those of common iron. Laboratory tests have shown the growth to be retarded up to 50 per cent of that of the regular iron. Although not a sufficient number of molds of this special iron have been used up to determine what increased service may be expected, preliminary results indicate quite improved mold life. It is expected that this may be a step toward bettering mold life through radical changes in mold analyses.

Market for Structural Steel Expanded by Advertising

The expansion of the market for structural steel through advertising, better merchandising, development of new uses and the application of technical research will be the theme of numerous addresses to be delivered in the course of a nation-wide speaking tour by Charles F. Abbott and Lee H. Miller, executive director and chief engineer, respectively, of the American Institute of Steel Construction.

Many of the addresses will be delivered before local groups of structural steel fabricators and before meetings attended by architects, engineers, contractors and public officials.

Notes on Open Hearth Furnaces

(Continued from page 19)

furnace men are made almost over night, and if a concentrated drive was made by companies today to systematically educate the open hearth workmen by round table discussions with them pertaining to the best way to get results it would repay on a large scale.

For any man to efficiently perform certain duties, that man must be thoroughly conversant with every phase of the situation. Not only will a reaction come from quality and tonnage, but will react in a sane use of materials and equipment, that will of necessity react in the cost of ingots.

With competition keen and customers' demands more rigid, the old hit-and-miss method is obliged to go.

If more time is devoted to enlightenment of the employee, or certainly as much devoted to making him more efficient as there is to designing and building equipment for him to operate, there can be only one answer. Improved quality and better costs.

Electrification of Rolling Mills in 1927

An Enumeration of the Types of Motors and Equipment for Driving Strip, Skelp, Continuous, Structural, Blooming, Bar and Merchant Mills—Outstanding Achievements Mentioned

By J. D. WRIGHT*

ONE of the most important recent achievements in the steel industry is the development of the wide strip and continuous sheet mill. The rolling of wide thin strip steel requires very highly powered mills and the tendency has been very decidedly toward individual drive for the various roll stands.

About the middle of the year the Trumbull Steel Company completed the remodeling of its 16-in. hot strip mill, which was first placed in operation during 1918. The mill is now laid out for continuous rolling and will produce a strip up to 36 in. wide. The driving power applied to the mill was increased by one new 5000 h.p. adjustable-speed Scherbius controlled induction motor, so that the total capacity of driving motors is now 13,000 hp. With the exception of one 300 hp. and two 100 hp. edger motors, which are adjustable speed direct-current machines, all the driving motors are of the slip ring induction type with speed adjustment obtained by the Scherbius system. The four horizontal roughing stands are driven by a 1500 hp. motor, and each of the last three stands is driven by a 2000 hp. motor. The speed of each motor can be adjusted between 270 and 450 rpm.

The Scherbius speed regulating set used with the 5000 hp. motor is of especial interest as it is the first application using two alternating current commutator type machines in series. This design permits the use of smaller and higher speed units, and the higher regulating voltage obtainable permits of designing the induction motor with a lower secondary current. In this particular case, the two commutator motors are direct connected to a 1175 hp. synchronous motor forming a three-unit set.

Another large strip mill recently placed in operation which is also equipped with General Electric driving motors is that of the Weirton Steel Company at Weirton, W. Va. This mill will produce strip up to 48 in. wide. There are 11 driving motors totaling 16,600 hp. The three driving motors on the roughing stands are 1500 hp. 6600 volt alternating current machines, one of which operates at 200 rpm. and the remaining two at 450 rpm. There are three edger motors, each 200 hp.-400/800 rpm. direct current. The five finishing stands are individually driven by two 2000 hp.-200/400 rpm. and three 2500 hp.-200/400 rpm.-600 volt d.c. motors. Power for the direct-current machines is obtained from two synchronous motor generators, each consisting of two 1500 kw. 600 volt direct current generators driven by one 4200 kv-a. 0.8 p.f. 6600 volt synchronous motor. The five direct current motors are started simultaneously by control of the voltage of the four direct current generators.

J. D. WRIGHT
General Electric Company

Skelp Mills

Two large mills of the continuous type for rolling skelp have been placed in operation during the year. One is at the Benwood (W. Va.) plant of the Wheeling Steel Corporation. This mill is provided with eight driving motors, all of which are adjustable-speed direct-current machines. There are four edger motors, three of which are 50 hp. and one 150 hp. These machines are operated from the 230-volt direct-current mill circuit. The main driving motors are 600-volt machines, power being supplied to them from a three-unit motor generator consisting of two 2000 kw. 600-volt generators driven by one 5600 kv-a.-4000 volt-60 cycle synchronous motor. The first two stands are driven by a 500 hp. 180/360 rpm. motor and the remaining eight stands by three 2000 hp. 200/400 rpm. machines.

The other skelp mill referred to, which is also equipped with General Electric driving motors, is the 27-in. 24-in. 21-in. continuous mill installed by the Bethlehem Steel Company at their Sparrows Point plant. In addition to producing skelp, this mill is also designed to roll sheet bar. There are four main driving motors. The first is a 4000 hp. 83 rpm. 6600 v. synchronous motor which drives the roughing train. The intermediate train is driven by a second synchronous motor rated 6500 hp. at 187 rpm. The third is a 6700 hp. slip ring induction motor with speed adjustment between 250 and 500 rpm. obtained by the Scherbius system. The driving motor on the last stand is a 600 v. d.c. machine rated 2600 hp. at 275 to 320 rpm.

---

*General Electric Company, Schenectady, N. Y.

Scherbius Regulating Machines

An unique feature of this installation is the method of tying together the Scherbius regulating machines for the 6700 hp. induction motor and the direct current generator which supplies power to the 2600 hp. finishing stand motor. This is accomplished by a motor generator consisting of five units, namely, the two regulating machines (R1) and (R2), a synchronous motor (S), a direct current generator (G), (for the 2600 hp. d.c. motor), and an exciter (E). The latter provides the necessary 250 v. excitation for the synchronous motor (S), the generator (D), the 2600 hp. d.c. motor, and the 4000 and 6500 hp. synchronous motors on the roughing and intermediate stands. The synchronous speed of the 6700 hp. induction motor is 375 rpm. with speed adjustment above synchronism to 500 rpm. and below synchronism to 250 rpm. When running below synchronism, the slip energy from this motor passes to the regulating machines (R1) and (R2) and these machines acting as motors assist the synchronous motor (S) in driving the direct current generator (G). If (G) were not supplying power to the finishing stand motor, the slip energy would be returned as electric power to the incoming line through the synchronous motor (S). However, when the finishing stand motor is loaded, the slip energy is available to drive this machine wholly or in part by supplying the driving power for generator (G). If the induction motor is required to run at speeds above synchronism the regulating machines (R1) and (R2) act as generators and the synchronous motor (S) draws from the incoming power line the energy which these machines and the direct current generator and exciter require.

Lackawanna Structural Mills

From the standpoint of the total horsepower involved, the new electrically driven Bethlehem wide flange beam mill for the production of structural shapes at the Lackawanna plant of the Bethlehem Steel Company is one of the largest mills in this country. The complete equipment consists of three units—a 54 in. reversing blooming mill, a 48-in. intermediate mill, and a 48-in. finishing mill. The finished sections are produced without any reheating of the steel from the time the ingot is removed from the soaking pit. The ingot is first rolled in the blooming mill to an "H" shaped bloom with a web from seven to twelve times the thickness of the web of the finished section. This bloom then passes to the intermediate mill, which

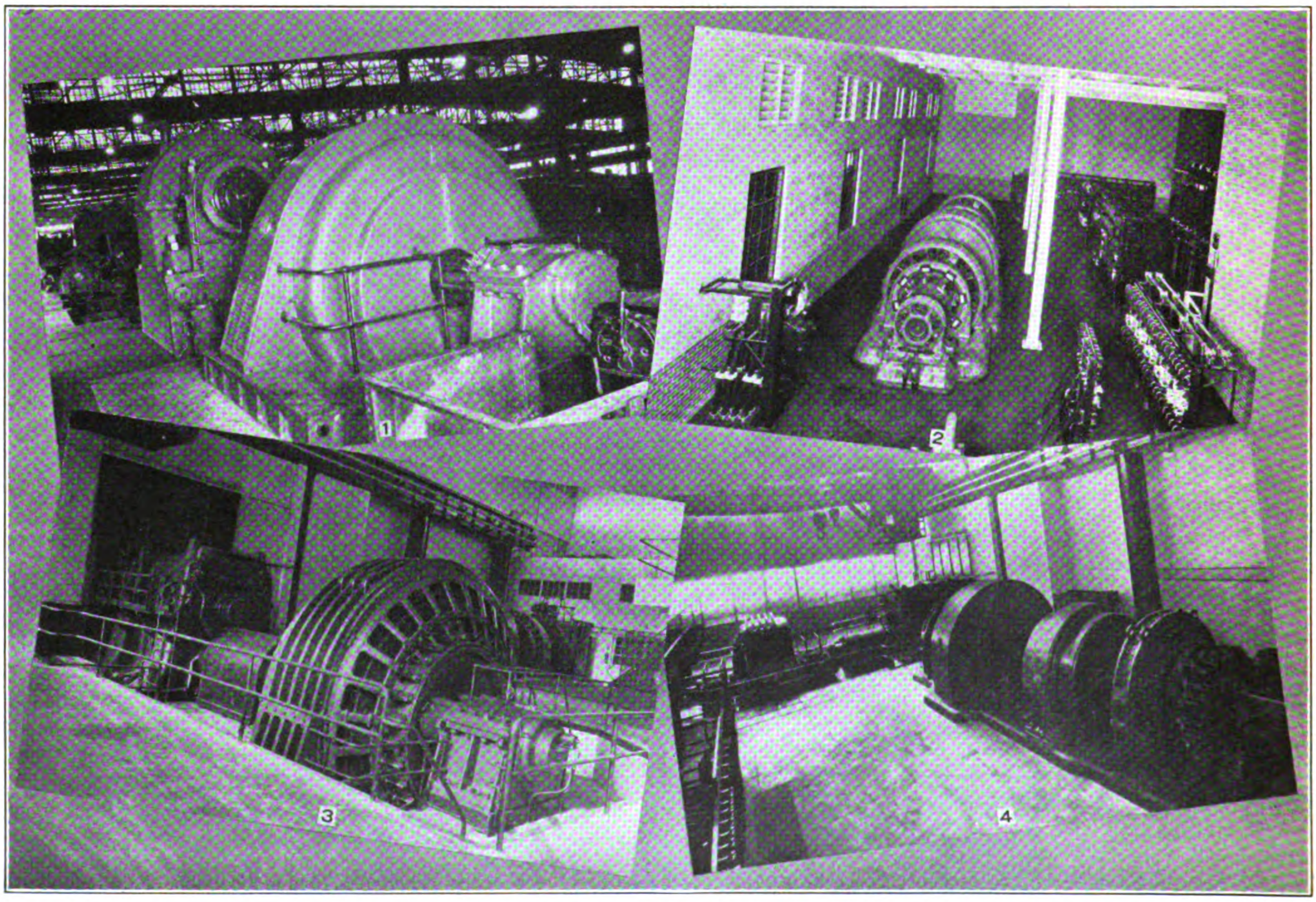


FIG. 1—5000 hp., 240 r.p.m., 2200 v., synchronous motor driving 51-in. piercing mill, Standard Seamless Tube Company. FIG. 2—General view of motor room 32-in. bar mill, Standard Seamless Tube Company, showing motor generator, switchboard and control equipment. FIG. 3—7000 hp., continuous rated 50 Crise 40/80 r.p.m., 750 v., d.c. motor driving 54-in. reversing blooming mill at Lackawanna plant of Bethlehem Steel Company. FIG. 4—General view 54-in. blooming mill motor room, Bethlehem Steel Company Lackawanna plant, showing 7000 hp., reversing mill motor and flywheel motor generator.

consists of two separately driven stands of rolls. One stand, known as the supplementary mill, has two horizontal rolls, and the main stand has two horizontal and two vertical rolls. The "H" shaped bloom enters this intermediate mill with the web horizontal. The supplementary rolls act only on the top and bottom edges of the flange. The horizontal rolls of the main mill effect the reduction in cross section of the web, while the vertical rolls reduce the cross section of both flanges. In the main mill the driving power is applied only to the horizontal rolls, the vertical rolls rotating due to their contact with the beam.

After several passes back and forth through the intermediate mill, the beam passes on to the finishing mill, which also consists of two stands—a main and supplementary—where several finishing passes are made.

The electrical equipment which was furnished for these mills is of particular interest. In the first place, the motor for driving the 54-in. reversing blooming mill is the largest single unit direct current rolling mill motor which the General Electric Company has ever built. It is rated 7000 hp. continuously—50 deg. C. rise at 40/80 rpm. This motor is capable of exerting a maximum torque of 2,400,000 lbs. at one ft. radius. Direct-current power is supplied from a flywheel generator consisting of one 5000-hp. 375 rpm. 6600 v. induction motor, one 50-ton flywheel, and two 3000-kw. 750 v. generators which are operated in parallel. This 54-in. blooming mill is one of the two largest reversing blooming mills in this country.

The electrical equipment for the intermediate mill consists of two reversing motors, one of which drives the supplementary rolls and the other the main rolls. The main roll motor is rated 7000 hp. continuously at 50 deg. C. rise, 65/125 rpm.; the supplementary mill motor is rated 1500 hp. continuously at 50 deg. C. rise, 65/225 rpm. The flywheel motor generator which furnishes power to those reversing motors consists of a 5000 hp. 375 rpm. 6600 v. induction motor, duplicate of that on the blooming mill set, two 3000-kw. generators for the main motor, one 3000-kw. generator for the supplementary motor, and one 50-ton flywheel. This set is a duplicate of the blooming mill set except that it has three generators instead of two.

The finishing mill equipment is the same as that for the intermediate mill.

The total capacity of the main equipment for the blooming intermediate and finishing mills is just about 71,000 hp.

The Bethlehem Steel Company placed an order with the General Electric Company for new electrical equipment for the Lackawanna rail mill. Engine drives will be discarded and the layout of the mill will be changed. It will consist of a 44-in. reversing blooming mill, the driving motor for which will be rated 7000 hp. continuously, 50 deg. C. rise at 50/120 rpm. Blooms from this mill will go to a 36-in. reversing roughing mill, which will be driven by a direct-current motor rated 5000 hp. continuously, 50 deg. C. rise, 50/120 rpm. Power for these two reversing motors will be obtained from a single flywheel motor generator consisting of one 8000 hp. 375 rpm. 6600 v. induction motor, two 3000-kw. 375 rpm. 750 v. generators operating in parallel to supply power to the 7000 hp. blooming mill motor, two 2200-kw. 450 v. generators operating in series to supply power to the 5000 hp. roughing mill motor, and one 75-ton flywheel.

Increasing Use of Synchronous Motors

The increasing use of synchronous motors for main roll drives is noteworthy. Seven motors sold by the General Electric Company during the year totaled 12,600 hp. The largest of these was rated 5000 hp. continuously, 40 deg. C. rise 100 rpm., 2200 v., and will be used to drive a 19-in. continuous sheet bar mill at the Kokomo, Ind., plant of the Continental Steel Corporation.

A motor of the same hp. rating, but at 240 rpm., is used to drive a 51-in. piercing mill installed by the Standard Seamless Tube Company at Ambridge, Pa.

The remaining five motors, two of which are 400 hp. and three 600 hp., drive copper and brass rolling mills.

The Standard Seamless Tube Company has also placed in operation a 32-in. reversing bar mill which is driven by a 2150-hp. 43/85 rpm. 550 v. d.c. motor. Power for this motor is derived from a synchronous motor generator consisting of a 4200 kva. 2200 v. synchronous motor direct connected to two 1000-kw. 275 v. d.c. generators operating in series.

At the Union plant of the Bourne Fuller Company, Cleveland, Ohio, a 10-in. merchant mill has recently been placed in operation which, from the standpoint of the electrical equipment, is of particular interest. The mill has eight driving motors totaling 3400 hp. Five are 500-hp. 267/800 rpm. 230 v. d.c. machines and three are 300 hp., with the same range of speed adjustment. The four stands which are driven by the three 500-hp. motors and one of the 500-hp. motors are in tandem and placed on very close centers, so that the metal being rolled is in all four stands simultaneously. For this reason special provision has been made in the control provided for these four motors to reduce the speed regulation (that is, the change in speed from no load to full load) of each machine to a minimum and to maintain within close limits the relative speeds of all four machines.

Review of Iron and Steel Literature for 1927

(Continued from page 23)

No. 57. Wrought-Iron and Wrought-Steel Valves and Fittings. 15 pp. 1927. 5 cents.

Technologic Papers

No. 331. High-Silicon Structural Steel, by H. W. Gillett. 121-143 pp. 1926. 15 cents.

No. 334. Relationships between the Rockwell and Brinell Numbers, by S. N. Petrenko. 195-222 pp. 1927. 15 cents.

No. 336. Comparative Tests of Six-Inch Cast-Iron Pipes of American and French Manufacture, by S. N. Petrenko. 231-254 pp. 1927. 15 cents .

UNITED STATES TARIFF COMMISSION

Iron in Pigs; Report of the United States Tariff Commission to the President of the United States; with Appendix, Proclamation by the President. 38 pp. 1927.

Differences in cost of production of iron in pigs in the United States and in the principal competing country, as ascertained pursuant to the provisions of Section 315 of Title III of the Tariff Act of 1922. British India is the principal competing country.

Outstanding Open Hearth Improvements

A Summary of the Modifications in Practice and Furnace Design Which Have Been Established During the Past Year as Viewed by a Steel Maker

By **C. W. VEACH***

WITH the year 1927 passed into history we look about to see what progress has been made in practice, and what new ideas have been brought out to improve the operation of the open-hearth furnace. A recent development in open-hearth construction which is the most radical departure from established rules, and which is most promising of further development wherein economies in operation and maintenance will be possible, is the new suspended roof.

While the chief advantage seems to be suspending the brick to remove the pressure developed by their own weight, thus correcting the spalling tendency of the bricks to a certain extent, and making it safe to operate after the roof wears almost through, one or two principles are shown to be dispensable where they were thought to be indispensable.

Most open-hearth roofs are of the hip type, but the question now arises whether the slope upward from the knuckle to the end of the furnace might not be advantageously eliminated, that is, carried through on the same plane from one end to the other.

The knuckle, drawn down as it is just at the point where the combustion of the fuel takes place, may operate to bring about a more intimate mixture of the fuel and air, but lengthening the bridgewall would have the same effect, and would permit a more perfect burning of the fuel before it reaches the bath thus allowing more of its heat to be given up to the metal bath.

Admixture of the air and gas will take place regardless of whether the roof over the air ports is sloped or straight, because the air is heavier than gas and will sink in it while the gas will rise through the air.

It is of course necessary to bring the fuel into the combustion zone on a downward angle because of the fact mentioned in the last paragraph, and there must be sufficient force behind it—this force is given the gas by the stack effect of the uptake—to cause it to follow the bridgewall and strike the bath before it begins to rise. By constricting the gas port it has to a small degree a blow-pipe effect, and this prevents the resulting flame from spreading all over the furnace and impinging on the side walls. It also gives a more intensive flame.

The slope of the gas port need only follow that of the bridge wall, and with the roof straight the only impediment in the way of the flow of the waste gases is the "dog house" or "monkey" which encloses the gas port. The ideal condition is, in the incoming end for the uptakes to be only of sufficient area to admit the gas and air at as high velocity as can be had, and on the outgoing end to minimize the friction between the products of combustion and the passages.

Where fuel oil, natural gas, powdered coal, tar, and perhaps coke oven gas, are used the open type of port is excellent. In the construction for the kinds of fuel mentioned the furnace is simply a rectangular structure having its four walls, bath constructed after the usual methods, and slopes leading up to the uptakes over which the fuel is brought in through the ends of the furnace by pipes or other means.

The straight roof is a much simpler construction than the hip roof, and whether sprung or suspended will give longer service, besides patches during a campaign are made with less difficulty on a straight roof than on the other kind.

The only suspended open-hearth roof on which sufficient data have been furnished to permit of any prediction as to its possible adaptation is the one at the Donner Steel Company at Buffalo, N. Y.

In this installation the results so far indicate that the suspended roof is going to prove a success. This roof made 480 heats with only minor patches being required, and it is my own personal opinion that the fact of its being straight throughout the length of the furnace—accounts in great measure for its long life.

The roof is flat, and it was a question with the engineers at what height to place it. The engineers decided to place it at the highest point of the old roof. This made the roof much higher than any open-hearth roof has ever been tried before, and was a radical departure from prevailing ideas of what the height of a roof should be, many believing that to be efficient the roof must be as low as possible. This roof has since been lowered but not to the level of the old skewbacks.

Besides a longer life it is reported that the front and back walls lasted longer with the flat, suspended roof, and this I take to indicate that after all the roof has something to do with the direction of the currents of radiated heat.

The only difficulty with the suspended roof is the complicated apparatus for holding the bricks in suspension. And the only drawback is the large cost of installation. However, these things will no doubt be modified so that the roof will be within the economical reach of all plants.

Stevens Insulated Furnace

Another development in open-hearth construction, and this applies to any kind of heating furnace, is the Stevens insulated furnace. In this construction all air infiltration is guarded against and loss by radiation is almost nil.

One feature, that of encasing the furnace proper in steel plates, is old, the writer having operated furnaces so encased more than 20 years ago, but the idea of insulating to prevent radiation and air infiltration has only recently received attention.

One of these furnaces has been in operation in the Chicago district the greater part of this year, and high efficiency is claimed for it. Whereas the average efficiency of an open-hearth furnace is only about 17 per cent based on the amount of the heat that is developed which is actually transferred to the metallic charge in melting and heating it, the efficiency of the Stevens furnace is said to be 36 per cent.

---

*Open hearth superintendent, Bettendorf, Iowa.

This figure is confirmed by the amount of oil required to make a ton of steel in this furnace. The amount being 22 gallons as against better than 40 gallons in other furnaces.

It is claimed that the temperature at the top of the checkers is 2600 deg. F. at the critical period of the heat, and this we all know is higher than ordinary. The preheated air reaches the combustion zone at a temperature that has very little depressing effect on the flame, this evidently is where the saving of fuel is made possible.

Steam is used to atomize the oil and heats are worked under a steam pressure of 22 lb., while the oil gauge shows a pressure of 10 to 15 lb.—this on a 30 ton heat. It is also claimed that heats of 30 tons can be melted in 3 hr., which, even for acid practice, is fast work.

There's one feature of insulating to prevent air infiltration that appeals to the metallurgist, this being that control of the furnace atmosphere is made possible. Without insulation it is next to impossible to regulate the air that enters the furnace, and we know that all excess air above a certain amount has a depressing effect on the flame temperature, and creates an excessively oxidizing atmosphere which is not conducive to high quality in the product. It is vitally important that we control the atmosphere to the extent that we know within narrow limits how much air is being admitted, particularly during the final stages of the heat.

After making 500 heats this furnace was shut down on account of clogged checkers, but it is claimed that wear on the furnace lining as well as in the uptakes was satisfactory.

From all indications insulation is going to prove a means of cutting costs by speeding up production and conserving fuel. Also it seems that a better product will result because the furnace atmosphere can be maintained more nearly reducing.

The operators of the unit we have discussed go so far as to mud up the openings where the oil burners pass through the walls, and close the wickets in the doors ; besides they have the doors and door frames made to fit snugly so no air can get in.

Preheating Air

A third idea which is being pushed at this time is an arrangement whereby the air is heated prior to entering the regenerative system. The merits or demerits of this scheme are unknown to me, therefore I can say nothing either for or against the idea. But any new idea which promises to improve the open-hearth furnace and make it a more efficient tool is worthy of consideration .

When this question was being discussed at the open-hearth committee meeting at Detroit in November, some one wanted to know how the furnace temperature would be controlled during the critical stage of the heat with air coming in at a high temperature. The answer was that it might prove necessary to by-pass the hot gases around the preheaters during the critical stage of the heat, and bring the air into the furnace at a reduced temperature, such as we now have.

It seems to me that the furnace temperature is controlled by the manipulation of the flame, adjusting it to suit the condition existing within the hearth or bath, and if the air is brought in at an abnormally high temperature the flame volume, and its intensity, would be reduced or increased as conditions would warrant as we now do. If preheating the air makes it possible to reduce the flame without slowing up the operation, then we should all install preheaters for the fuel they would save us.

A considerable amount of interest is shown in the Isley plan for furnace control. The principal feature of this idea being the removal of the waste products of combustion without the usual tall chimney. Another feature is the reversal of the induction fan to force air into the flue and thence into the regenerative system for preheating as it passes on its way to the combustion chamber. The fan alternately forces air into the furnace then, on being reversed, draws the gases out and delivers them to a short stack through which they are carried to waste.

The advantages that are claimed for this idea are better control of the furnace, elimination of expensive chimneys, economy in the use of fuel, a reduction in the capacity of the regenerators, etc. Having had no opportunity to study the performance of a furnace equipped with the Isley apparatus I can offer nothing in the way of criticism nor commendation.

Sloping Backwall

During the year a good deal of discussion has had to do with the proposition of sloping open-hearth backwalls so that material—a mixture of chrome ore and magnesite or dolomite, or chrome ore alone—can be made to stick up on the wall, and will sinter there forming a clinker which withstands the high furnace heat, and protects the brickwork making it, as some claim, last almost indefinitely.

It is claimed for the sloping backwall that by starting the offset below the foreplate level the area of the bath is increased, and the wall can be effectively covered with a material that will sinter in place and form a protective bank without encroaching on the bath. Whereas building up such a bank against a vertical wall causes encroachment of several inches on the bath because the bank requires a thick base to support it. And even with a heavy base, encroaching several inches on the bath, some of the material that is added from time to time will roll down into the bath and be lost because the degree of slope is not sufficient to induce it to stick.

The idea of the sloping backwall is to prolong its life so that hot repairs at this point will not be quite so frequent, and the delays such repairs cause will be avoided. During the present year we have been successful in protecting both the front and back walls so effectively, by using a special furnace chrome ore, that only one week-end repair was necessary during a campaign of 457 heats. A discription of this feat will be given under "Development in Practices" in this article.

Use of Chrome Brick

An attempt is being made by one ceramic corporation to substitute chrome brick for magnesite brick in the lining of basic open-hearth furnaces. Besides advocating chrome brick for the bottom of the hearth, this company is experimenting with chrome with the idea of developing a brick that will stand up in the side walls and ends of the furnace, and to be used as linings in the downtakes as it is thought chrome will withstand the abrasive action of the solids carried over in the waste gases better than silica.

The difficulty to be overcome is the tendency of chrome brick to crumble under high heat, but if this tendency can be overcome improvement will result for chrome is less pervious to attack by slag particles than silica or magnesite.

There is one other item of recent development which I think is very important. We of course endeavor to operate without having a spill occur, either a breakout somewhere in the furnace, or while pouring from the ladle. But accidents will occur around the best regulated open-hearth plant, and occasionally the whole or a part of a heat gets out of control resulting in part of a heat being dumped in the most convenient place that is offered.

When finally broken up there is usually one or two chunks left that are in a more or less unwieldy condition, and to break or burn them apart so that they can be charged in the usual way is very costly. The prevailing method of disposing of such pieces of scrap is to charge them in the bottom of a furnace that is down for repairs and put the roof on afterward.

Starting up a furnace with these heavy pieces of scrap on the bottom is a makeshift at best, and the heat made under a condition of this kind cannot be short of rotten. And it is difficult to see where any economy is made by practice of the above description; however, this practice has prevailed for years.

Handling Large Scrap at River Rouge

At the River Rouge plant of the Ford Motor Company, they have provided special doors on one of the furnaces built recently to take care of unwieldy pieces of steel, and it is obvious that great savings are possible, not only in preparing pit scrap for charging, but less cutting or breaking will be required in preparing other kinds of heavy steel such as engine frames and die blocks, etc., for charging.

By having these wide doors fit the frames snugly no excess of air will leak in, and all the drawback they offer is the cooling effect of the inrushing air when the doors are raised for charging or to add material to the bath while working the heat.

Another feature of this furnace is the steel encased front, being water cooled no radiated heat will make it uncomfortable for the operators. And in this respect it might not be amiss to say that in this openhearth plant working conditions are on an order far higher than anything ever dreamed of by even the most visionary.

Development in Open-Hearth Practice

The fundamental principles which govern the openhearth process are, like the principles governing any industry or laws of nature and are immutable. And when they are rightly understood and properly applied no further improvement is possible. But since a better understanding of metallurgical problems is being brought about it follows that our understanding of the principles of metallurgy has been incomplete—is still incomplete—and may remain so for years to come.

Though progress has been slow at times, it has nevertheless been sure, but the caution with which old practices are changed makes it difficult to define what is new. So for this reason we can do little more than give an outline of the efforts that have been made during the present year to improve practices.

First, all steel producers have endeavored to increase production without going to the expense of changing the melting unit to suit the added burden, and in some cases at least this has been accomplished to an extent that surprised the most optimistic.

In every instance which has come to my notice where the heat has been made larger by deepening the bath, and working with thinner banks, a saving in fuel and labor resulted because the heat period was not changed—or only slightly changed—and the cost of bottom upkeep and maintenance of the brickwork decreased accordingly.

Furthermore, by deepening the bath the quality of the product was materially increased, and oxidation losses were less. The aggregate of savings made by increasing the size of the heats are a source of satisfaction to the open-hearth executive as well as to the management.

Second, I think a closer scrutiny of detail, by the executive, of all practices has operated to correct inefficiencies, and has resulted in economies. At least I can say this has been my own personal experience.

Third, co-operation between departments, and particularly where the condition of the product leaving the department affects the operations of the department receiving it. And, too, co-operation between the melting department, the purchasing and the stock departments is found to be highly important. This I believe is more fully appreciated now than ever before. I think it can safely be said that this factor of a smoothly operated industrial organization has operated more satisfactorily during the last few years than formerly.

Carbon, Manganese and Silicon

Open-hearth superintendents almost without exception are studying the effect of some of the ingredients (commonly called impurities), such as carbon, manganese, and silicon, in pig iron and what should be the various limits of these ingredients as written in the specifications for pig iron bought.

The majority want high manganese and as low silicon as can be had in iron made in a hot blast furnace. There is considerable improvement in the selection of materials for melting.

The question which was referred to earlier in this article in regard to the use of chrome ore for protecting jambs and back walls was on the program at our Detroit meeting, but did not come up for discussion on account of the fact that there was not sufficient time.

However, the writer discussed this problem with several of the members of the committee outside of the regular sessions, and it is evident that chrome ore is used extensively for this purpose, and that maintenance costs are reduced by it. Following is a description of what has been done in the way of making hot repairs unnecessary by using a special furnace chrome ore to bank up against the jambs and back wall after they begin to get thin, and evade loss of time. This practice is followed at many steel foundries besides several ingot plants.

Practice in Using Chrome Ore

When the furnace has been in operation for about four weeks the back wall and jambs show considerable wear, and if not protected these parts of the lining will be ready for repair after about 140 to 175 heats have been made. Then after another period in which about 100 to 140 heats are made these parts are ready for a second repair.

It sometimes occurs that the second repair comes after about 275 heats have been made, and often the roof has worn away about half in certain sections and will not permit cooling down, yet is good for many more heats as long as it is kept hot. But if the roof will stand the second repair to the front and back walls, when these wear out it will seldom permit of cooling down to repair them again, for the furnace will have made about 400 heats and the roof is well worn in places, yet if undisturbed—that is, not subjected to the abuse of contracting and expanding while cooling down and being heated up again—will continue in service till several more heats are made.

The hardest use a furnace roof that is getting thin can be subjected to is cooling it down and then heating it up again, for when it cools down the brick contract and the roof settles, and when heated up again the brick expands and the roof rises. But some parts are thicker than other parts and an unequal strain is set up, the heavy sections forcing the thin sections to buckle and spoiling the arch. A roof that is buckled is apt to fall in and cause the loss of a heat.

Five hundred heats is not too much to expect a furnace to make on a roof, but to obtain this long life absolute control of the flame is required, and after the roof brick have become well worn the furnace must be kept red hot the remainder of its life so that no shrinkage and settling takes place. This will permit of wearing the roof down very thin before it is in danger of falling in.

On the furnace that made 457 heats with only one week-end repair, it was operated eight weeks after the jambs had become so thin that they were barely able to support the arches over the doors, the back wall was also thin.

Each week-end the furnace operators built up banks of chrome ore, starting with the base about 10 in. diameter and carrying the bank up to the skew back of the arch where it tapered out to nothing.

The back wall was covered in the same way, but this job was not as smooth as the front banks, and some material was lost while it was being applied—shoveled on.

However, the cost of the chrome ore was not large and over $1800 was saved on the maintenance cost for the furnace campaign, in addition the expense attendant on cooling down for several week-end repairs was avoided resulting in a saving of fuel and production time.

Besides having a very low maintenance cost during the life of the furnace, these walls of chrome ore at the front and back prevented silica from entering the bottom at the slag line resulting in a low bottom repair cost.

Every open-hearth operator experiences more or less difficulty in keeping the tap hole in a stationary basic furnace up so that his tap is satisfactory.

We want the hole low in relation to the bottom, and we want the bottom to slope from all points down to the hole so that it will drain freely and cleanly when the heat is tapped. Also we want the hole to be just the right size and shape so that the metal leaves the furnace before the slag; it does not do so if the roof of the hole is too high.

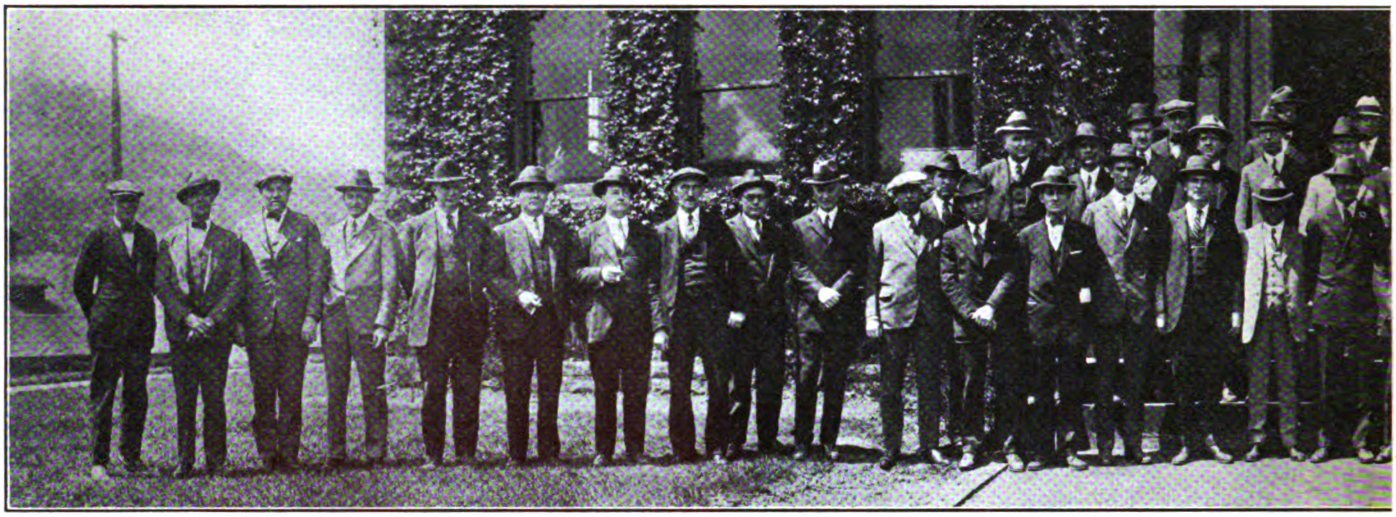
A heat that has been worked down with supreme care and is thoroughly deoxidized may be spoiled when it is being tapped because a bad taphole permits the slag to run out when only a small portion of the metal has left the furnace, causing slag and metal to mix as they fall into the ladle. This intimate mixing of metal and slag results in a heat that is highly charged with iron oxide. And the recarburizer that is added to the metal in the ladle is wasted because it is taken up by the slag.

Only a very few open-hearth plants have so far solved their tap hole problem, and they have done so by using a material that is expensive when the purchase price alone is considered. But when buying a material its cost is not the first consideration, its utility should always outweigh its cost. The question being how essential is its use to produce a condition that is satisfactory.

It is recognized by all open-hearth executives that improved methods of applying the principles of metallurgy are both desirable and possible, and to this end efforts are now directed.

Steel Mill Motors Furnished in 1927 by the Allis Chalmers Company

American Brass Company—
  One 800-hp. slip ring, hot mill.
American Manganese Steel Company—
  One 250-hp. slip ring, hot mill.
American Electrical Works—
  One 500-hp. synchronous, hot mill.
  Two 400-hp. synchronous, hot mill.
  One 75-hp. d.c., hot mill.
American Steel & Wire Company—
  One 500-kw. motor-generator set.
American Sheet & Tin Plate Company—
  Two 350-hp. slip ring, cold mill.
American Smelting & Refining Company—
  One 125-hp. squirrel cage.
  Three, total 100-hp., squirrel cage.
Bethlehem Mines Corporation—
  Two 300-hp. squirrel cage.
Central Alloy Steel Corporation—
  One 3750-hp., d.c., hot mill.
  One 3000-kw. flywheel motor generator, hot mill.
  One 100-kw. exciter.
Gulf States Steel Company—
  One 600-hp., slip ring, hot mill.
Illinois Steel Company—
  One 1250-kw. motor generator set, mill supply.
Interstate Iron & Steel Company—
  One 6000-hp., slip ring, hot mill.
National Tube Company—
  One 2550-hp., slip ring and control.
  One 300-hp., synchronous for driving pump.
  Two 400-hp., d.c., hot mill.
  Two 3000-hp., synchronous, hot mill.
  One 1500-hp., synchronous, hot mill.
Merton Steel Company—
  Ten 500-hp., d.c., cold mill.
St. Louis Smelting & Refining Company—
  One 150-kw. motor generator set.
Washburn Wire Company—
  One 600-hp., slip ring, hot mill.
Washington Iron Works—
  One 400-hp., slip ring, hoist.
Sloss-Sheffield Steel & Iron—
  One 200-hp., motor generator set.



GROUP OF OFFICIALS OF THE STEUBENVILLE

The History of the Refractories Industry*

Manufacturing Process Dependent on Refractories — Growth of Industry Traced — Business Now Well Organized — Co-operation Between Producer and Consumer Emphasized

By J. D. RAMSAY†

THE refractories industry is engaged in the manufacture and distribution of materials that will withstand conditions where high temperatures are present. It is one of the most important basic industries. Practically nothing can be produced without the use of refractories, directly or indirectly. They are used directly in the manufacture of steel, glass, brass, chemicals, and so forth, and indirectly in the production of electricity, gas, wearing apparel and household supplies. In fact, nearly all commodities are dependent upon refractories to some extent.

This paper was presented before the joint session of the American Institute of Chemical Engineers and the American Refractories Institute, at the Hotel Chase, St. Louis, Mo.

The American Refractories Institute is publishing much information of value to those concerned with the disposition of refractories in the steel plants. To obtain such information a Fellowship is maintained at the Mellon Institute of Industrial Research. Steel plant officials should avail themselves of the services thus offered by the Refractories Institute by addressing the secretary in the Oliver Building, Pittsburgh, Pa.

Refractories play an important part in our everyday life. Bathroom fixtures could not be produced without them. The silver and china on our tables are direct products. The gas that prepares our meals and the electric light and power in our homes are produced from some type of furnace in which refractories are used. Natural sunlight is brought to our rooms through glass made in refractory lined furnaces. There is no known substitute for refractories and they are essential in the production of every finished commodity. If this industry were to cease production for six months and no substitutes were to be found, business would be paralyzed.

Industry Founded in New Jersey

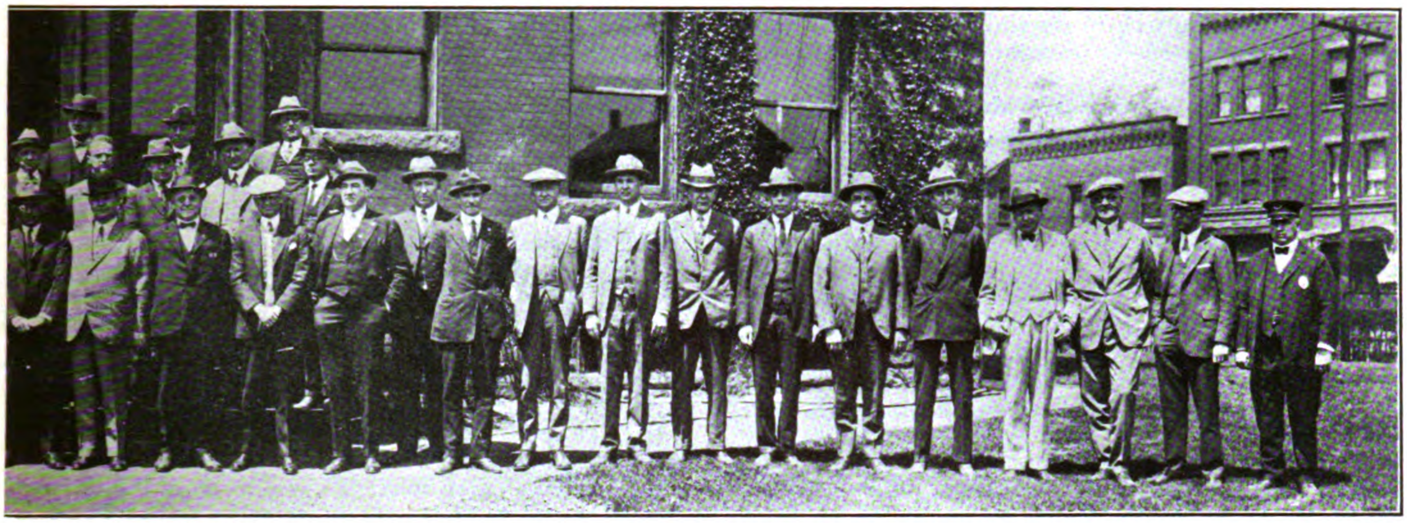
It is rumored that the industry was born in 1812, but we have no authentic proof. The records indicate that it was originated along the Raritan River in New Jersey in 1825. It grew and spread through that state to a considerable extent; and, although that was a hundred years ago, it is in a very healthy condition today. Like our Puritan Fathers it had the "wandering spirit." Consequently, a member of the family established itself among the lumber camps along the Susquehanna River in Pennsylvania about 1836. That family spread throughout Western Pennsylvania and increased more rapidly than its New Jersey cousins. Today some five or six counties of Western Pennsylvania produce probably two-thirds of all the refractories made in the United States. Another member of the family established a settlement in Maryland, about 1837, and is still doing a thriving business. The movement continued westward, and a settlement was established at Wellsville, Ohio, in 1846. That same year members of the family moved to Missouri, prospered, and increased so rapidly that it is today the second largest producing district in the United States. In about 1870 the family that established itself in Kentucky prospered so much that it is now the fourth largest producing district. About the same year another settlement was made in Ohio, in the vicinity of Canton, and that, too, has grown and flourished to a marked degree.

We have very little record of the annual production prior to 1870, but indications are that the growth was

---

*Printed by permission of the American Refractories Institute.

†President, The Elk Fire Brick Company, St. Marys, Pa.



PLANT OF THE WHEELING STEEL CORPORATION

very slow up to that time. We find that in 1870 the total production was something like 60,000,000; in 1880, it was a little over 163,000,000; in 1890, it had jumped to 391,000,000; in 1899, it had reached 800,000,000; in 1909, 838,000,000; in 1919, 1,174,000,000; while in 1926 the records indicate a production of approximately 1,300,000,000. This shows that it doubled its capacity each 10 years until 1919, when the gain over 1909 was about 50 per cent. According to the best information available, the refractories industry has spread to 19 states, tabulated below according to their present production: Pennsylvania, Missouri, Ohio, Kentucky, Illinois, Maryland, California, New Jersey, Colorado, New York, Washington, West Virginia, Georgia, Connecticut, Alabama, Texas, Indiana, Utah, Montana.

In order to transport the stupendous output to the market it requires something like 100,000 railroad cars of average size, which would make a solid freight train reaching from New York to Chicago. If these brick were laid end to end, or flat, they would reach around the earth five times, making a band nearly 2 ft. wide and 2½ in. thick. It is the equivalent of approximately 5,000,000 tons of material annually and is no small factor in the revenues of the railroads of this country. So much for the physical development.

Distribution of Brick

The development of scientific distribution has not kept pace with the increase in production. Up to 1870 most of the brick were traded. For instance, the manufacturer would trade his refractories for such supplies as iron, nails and shovels, which he in turn sold through supply stores to his employes and townsfolk. This may be called the trading period, during which there was no scientific development.

The next period developed "selling" methods, but even then practically no scientific study of the products and service was made. It will be noted that the production jumped from 153,000,000 to 323,000,000 during this period. This tremendous increase in production had to be disposed of and competition was keen, thus developing the art of salesmanship.

The period from 1890 to 1910 was a "good fellowship" period. Production increased so rapidly that in the 20 years it doubled itself. Salesmanship had already been introduced, the salesman had been developed and his points of contact were selected. He entertained, he gave gratuities, he provided pleasure trips and at times paid out considerably money in plain graft. It is obvious that no scientific development was possible. Another difficulty arose at this time. During the great steel boom from 1898 to 1907, unheard-of quantities of fire brick were required for the building of coke ovens and blast furnaces. Great steel plants were built, the capacities of the fire brick plants were taxed to their utmost, and the byword was production rather than development.

The next period, from 1910 to 1920, was a real awakening period. The producer and consumer alike felt the need of research for better products, or a more thorough knowledge of refractories and their limitations. Production increased from 850,000,000 to more than 1,200,000,000. It was a highly competitive period, especially until 1915. The World War retarded this research progress, however, for from 1915 to 1920 production and more production was the watchword. The consumer did not question quality, the producer forgot about it. It was purely a matter of getting out quantities. New plants were built, face brick plants converted into fire brick plants, and every facility used to get increased output. As a consequence, research was again set back, this time due to the great demand brought about by the war. However, a research laboratory was established by the Bureau of Standards in 1910 and the equipment of similar laboratories followed. In 1917 the Refractories Manufacturers' Association established one. Had it not been for the interference of the war, this last period would have developed greatly along research lines. As it is, only a start was made, leading into the period of research in 1920.

"Better Refractories"

The call for greater production ceased and in its stead came a new one, namely, "better refractories." The war and, incidentally, the income tax laws, brought to the industry better bookkeeping, more complete accounting systems, the consideration of depletion, depreciation, obsolescence, and last, but not least, a cost system. The latter began to point its fingers to high costs of operation. Among other things it pointed to refractories and their service. That in turn forced tests, trials and research in the individual plant where refractories were used. It brought specifications, criticisms and technical discussions, while at the same time the producer was brought to realize the necessity of better products and a more thorough knowledge of his material and its uses. He made an effort to find the reason for this dissatisfaction. He began to investigate service conditions and to realize that many factors enter into the use of his material. The necessity of improving the workmanship of the product was realized, which led to scientific use of reliable research laboratories. The manufacturer searched for the limitations of his material, where it was weak and how it could be strengthened. He learned, for instance, that the degree of fineness of grind and the hardness of the brick have a bearing on the length of service. All in all, he became thoroughly awakened to the importance of his industry and the necessity for making a better product. Today this is all being accomplished through organization and co-operation. The consumer and the producer now realize that their interests are not inimical, but one and the same. They know it is necessary to have the best co-operation possible; for the consumer to know what he is buying and what he is buying it for; for the producer to know what he is selling and what it is to be used for. The result is better refractories today than there were yesterday—much better refractories in 1927 than in 1921. Proof of this lies in the small increase in production in 1926 over 1920, notwithstanding the tremendous increase in the industries in which the material is used.

Now that the consumer's interest has been stimulated, the result is that technical men have in a large measure been given control of refractory problems. This makes possible a better correlation of properties of refractories and application to service, and, on the part of the consumer, a better understanding of the limits and properties of refractory materials.

These conditions going hand in hand have resulted in greater service from nearly all refractory materials. Increased service is not as apparent as might be expected, since practically all furnace operations have been more severe in recent years. The demands on refractories are such that their life in service may not appear to be any longer than formerly; but the fact remains that if refractories had not kept pace with the service requirements, a different set of conditions would exist.

Value of Technology

It would be very difficult to estimate the value derived through technology. The comparatively few men in the industry who are in a position to devote the major part of their time to technical problems and literature are in a position to realize the trend of technical development. At the present time there is an exceptionally deep interest in all phases of refractories technology, and the significance of service conditions as affecting refractories is apparent to the technician. In years past the handicaps of the research man did not enable him to obtain the factors or conditions which determined the life of refractories in service. Recent studies of service conditions through the co-operation of the consumer supply fundamental information which is having a marked influence on the nature of research work. This information is enabling them to design and develop tests which will actually supply information regarding the behavior of refractories in certain types of service. Testing in the past has not supplied authoritative information in this direction, and, therefore, has not been made use of to its fullest extent. It is only through the insight of the actual behavior of refractories in service that products can be materially improved.

In conclusion, there is, in the writer's opinion, a tremendous economic loss in the failure of the producer and the consumer to work closer together. The price of the brick ought to be a secondary consideration; the object should be to get longer life out of every lining than the one previous. Every reliable producer in this business is exceedingly anxious to get a superior product and to furnish something which will last longer. He is willing to spend money to do it, if he knows what is required; he is prepared to conduct studies in his factory and in the place where the brick are to be used. Likewise, every consumer is keenly interested in getting a superior product. He is not so much interested in what it costs as how long it will last. He understands his requirements and service conditions better than any producer, while the producer understands his own product, its limitations and its possibilities, better than any consumer. It is entirely obvious that if these two get together and exchange information the net result will be better refractories and longer service. If the producer knows what is expected of his brick and the service they are to perform he will be able to materially improve them for that purpose. If the consumer could realize what the manufacturer can do when he has this specific information he may be able to get immediate relief for his troubles. It is a lamentable fact that the producer or his representative is frequently prohibited from seeing the engineer or superintendent of the plant where his product is being used in order to get first hand information on service conditions. The reverse is true, in that these operators are not able to get in touch with the producer. This is a barrier which should be removed, and so long as it exists any effort to improve the product will be retarded.

Perhaps finer grinding, or light burning, or a change in the mixture might double, or even triple the life of a refractory. Possibly a moderate duty brick is used where a high grade one should be served. Perhaps a high quality is demanded when a moderate duty would last many times as long. Co-operation should be the watchword. How can the producer make a better brick for a certain purpose, unless he knows what that purpose is? How can he furnish something to give better service, unless he understands the service conditions? There is nothing to take the place of this all important contact between manufacturer and user.

Information obtained through co-operation with the consumer will be of great value in the outlining of research problems. There are a number of laboratories especially equipped for research in the field of refractories whose work in the past has been of great value, but whose future progress will be largely affected by the relation between the user and producer. The equipment is available and there is a willingness to proceed. With closer co-ordination and a wholehearted purpose, there is no limit to future progress.

Steel Treaters Move

The American Society for Steel Treating, which since 1921 has maintained its national office at 4600 Prospect Avenue, Cleveland, on December 1 moved into more spacious quarters at 7016 Euclid Avenue. Lack of sufficient space prompted the change.

The Open Hearth Furnace in Leash

A Concise Description of One of the Most Radical Departures in Furnace Control and Operation Since Siemens Conceived the Regenerator

By G. A. MERKT*

ONE of the most distinctive contributions to furnace design made in recent years is the Isley Furnace Control as installed by the Morgan Construction Company in a number of open hearth furnaces. This patented device is an ingenious arrangement of power apparatus by the regulation of which the supply of the elements of combustion as well as the removal of their products may be altered at will to any degree of activity and accuracy desired. The nature of the arrangement adds important properties to the furnace system and has embodied in it a number of features which make for valuable improvement in fuel economy as well as in the furnace process itself. The product also is said to be improved by furnaces equipped with this unique apparatus.

G. A. MERKT
Morgan Construction Company

The stream line venturi type of stack in large power houses is sufficiently known to serve as an example of modern methods of exhausting furnace gases into the atmosphere. The Isley exhaust tube is similar to that used in power plants, except that in the latter a part of the furnace flue gases is used as propelling fluid for the ejection of the balance, whereas in the Isley control, fresh air enters the venturi tube through its fan. Another deviation from the usual power house system and from other combustion control systems is the duplex arrangement of the venturi tubes with their respective fans, which perform the dual duty of ejecting the furnace gases at one time and of furnishing the air for combustion at another. Fig. 1 shows a typical pair of Isley venturi tubes surrounded by an enclosure in which the fans and their motors are sheltered against the weather. Fig. 2 is a conventional view of an open hearth furnace with its regenerator chambers folded out and each end of the furnace system equipped with an Isley control unit. With the throat damper of one venturi tube closed and that of the other tube open, the above mentioned dual performance of each of the two tubes and their fan equipment is apparent. The respective performances are reversed as the relative positions of the small throat dampers are reversed. Fig. 3 shows the general arrangement of the venturi tube with its throat and throat damper, the nozzle, which is connected with a low pressure fan mounted on the outside on its own foundation, and the motor driving the fan. The tube is lined with fire brick and insulating material up to the throat, beyond which no further lining is required as the furnace gases are mixed with cold air in the throat and are wasted beyond this point. The gradually widening funnel is no higher than local conditions may make advisable as it is merely used to insure the lifting of the flue gases above surrounding buildings or yard cranes.

While the Isley control apparatus produces mechanical draft of definitely adjustable value, there are no moving parts exposed to high temperture and, on account of this feature, the equipment is free from wear and deterioration.

Weather-Proof Control

The ejector process of the Isley control is based upon the dynamic properties of fluids in a venturi tube as found and mathematically determined some 50 years ago by Dr. Zeuner, in Switzerland, and more recently analyzed in an exhaustive technical treatise on the subject of ejector blowers, by von Ihering.

In the laboratory of the Morgan Construction Company, at Worcester, Mass., a large testing outfit has been installed, by means of which many of the perplexing and complicated phenomena as encountered in furnace draft problems were cleared up for the best tube design. Each installation requires careful study and selection of properties in order to produce a wide range of flexibility under all possible operating conditions without loss of control property over this entire range. Once the correct nozzle, throat and tube proportions, as well as fan and motor capacities, have been established, the combustion process is definitely controlled by the regulation of the output of each fan. No damper throttling or valve settings are required, in fact, such appurtenances are absent in this furnace system. Since for every pound of atmospheric air discharged through the nozzle a definite weight of flue gas is lifted through the throat, regardless of flue gas temperature or density, the rate of flue gas removal remains constant as long as the fan output is so. The draft pressure takes care of itself and adjusts itself automatically to the flow of the flue gases within the range of capacity chosen for the individual installation. This is illus-

---

*Morgan Construction Company.

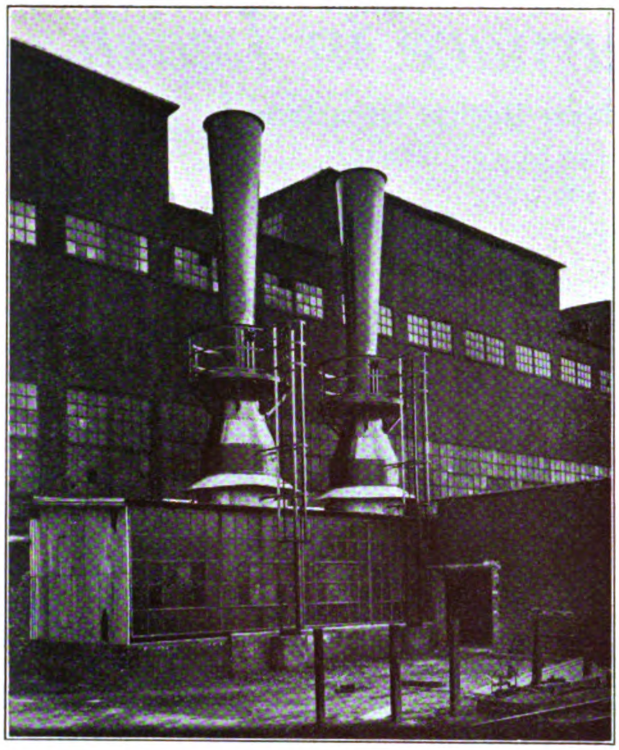


FIG. 1

trated diagrammatically in Fig. 4, in which the ordinates represent fan output and flue gas weight, while the abscissa is the draft pressure. As will be noted, for any given rate of flue gas removal the draft may be from ½ in. to 2 in. between points "A" and "B," depending on the equivalent orifice of the furnace system, i. e., its absolute resistance. If, however, say 1-3 less flue gas is to be removed, then the same furnace system will produce only ⅜ in. to 1⅜ in. draft resistance as indicated between identical points "C" and "D," while fan output and horsepower will come down in direct proportion to the smaller weight of flue gases handled by the ejector tubes.

The ejector type of mechanical draft eliminates all influences of weather, wind, atmospheric and furnace temperature, and makes the control of the furnace entirely independent. The output of each fan is simply regulated so as to obtain the rate of complete combustion desired with the least amount of excess air which produces sufficient flame luminosity in the hearth. Since there are no leaky reversing valves in the flues, and since the air for combustion is measured, so to speak, by the ingoing fan, an ideal furnace atmosphere can be maintained in the hearth chamber. This is of appreciable benefit from the metallurgical point of view in that it eliminates excessive metal losses due to oxidation, and results in a better steel.

Reversing by Temperature

Again referring to Fig. 2, it will be observed that in a furnace equipped with the Isley furnace control not only the regenerator chambers but also the flues and the ejector tubes themselves become regenerative in nature because the air enters the system almost at the very point where the flue gases are being released to the atmosphere. Long flues are no longer an expensive detriment but a good investment, in that they extend the regenerative power of the system. The entire structure becomes an elongated regenerator with gradually diminishing temperatures so that the operating heat exchange in each part remains within narrower extremes from reversal to reversal than is the case where fresh cold air enters directly into the previously heated checker chambers. On the other hand, as would be expected, the air returning to the port, on account of having been preheated before going through the checkers, is much hotter and the fluctuation of the air temperature considerably smaller at the ports. Reversing with the Isley furnace control is done by the temperature of the waste gases and not by the clock. For any given checker and flue construction and with a chosen rate of fuel consumption, there is a definite temperature saturation point which, after it has been reached, must not be maintained any longer than the time necessary to reverse the furnace. This temperature saturation point is like a relief valve, letting the heat escape into the atmosphere and ground as fast as it is supplied, and the degree at which it is located depends upon the amount of insulation used, the relative amount of radiating surface and a number of other factors. Fig. 5 is a reproduction of a temperature chart taken from a 40-ton acid open hearth

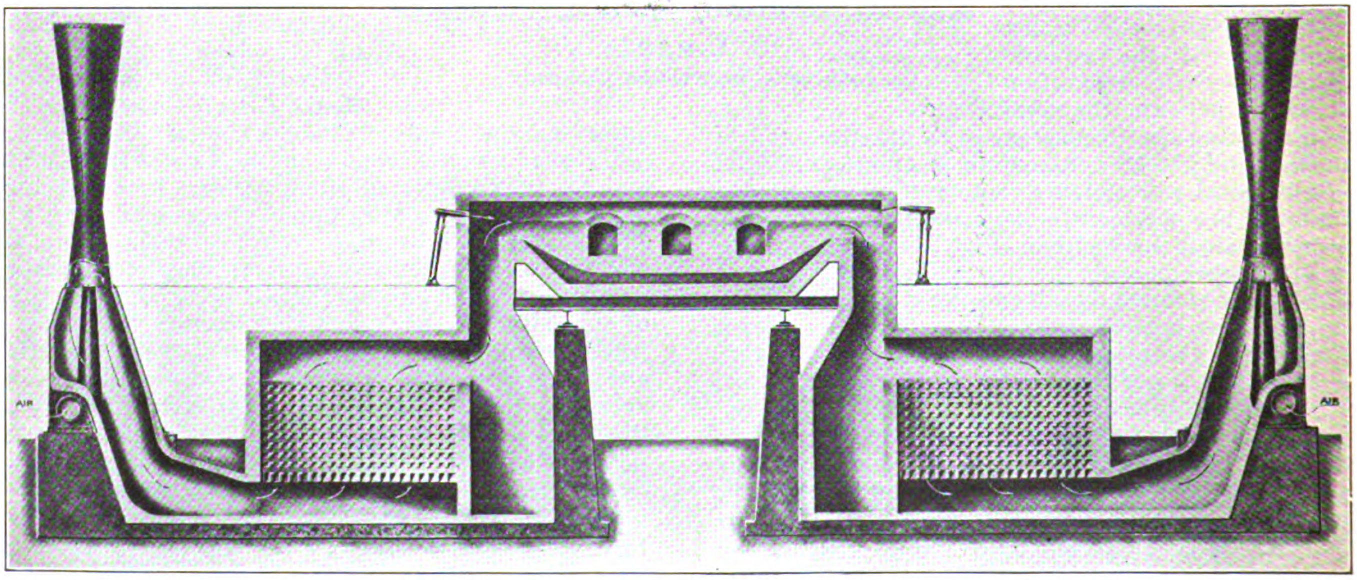


FIG. 2

furnace and shows clearly the approach of the saturation point at each reversal. The left hand half of the chart shows the temperatures of one flue-end taken at two points, one in the venturi tube about 18 in. below the throat, and the other in the flue leaving the regenerator chamber and beyond a set of secondary checkers which are filling up a portion of this flue. Thus two parallel curves are produced which indicate the temperature gained by the air from the regenerative arrangement of the Isley control. Note the parabolic shape of these curves and that the descending curvature is inverted as compared with the ascending curve. This inversion is responsible for a drop in average temperature of the ingoing air below the average temperature of the outgoing gases, and, the greater the curvature, i. e., the longer the reversal period, the larger becomes this temperature difference of the averages. Too short a reversal period on the other hand involves losses due to interruption of combustion, the running-off of the flue gas tail ends and, in the generally known type of reversing valves, leakages and infiltrations. In each installation there is found a most economic reversal temperature peak which may be adopted for the best operating practice and used as a guide for the proper process of reversing. For this purpose indicator lights are thermostatically operated by the recording pyrometer. First, a white light appears giving the furnace man a warning that the peak temperature is being approached, and then a red light goes on upon which signal the furnace is reversed. In fuel oil, natural gas or coke oven gas fired furnaces, the Isley control apparatus, together with the fuel supply, is reversed in four to five seconds and the reversal losses mentioned above are therewith reduced to a minimum. It will also be noted that with this method of governing reversals, the periods become longer as the heat progresses and the fuel rate decreases.

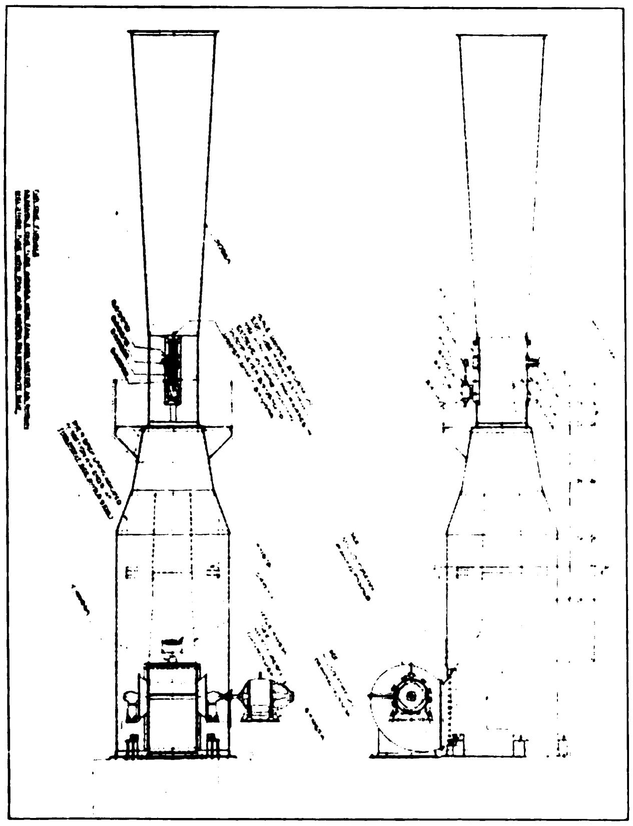


FIG. 3

Furnace Study vs. Nominal Capacity

In order to secure flexibility and sensitive response of furnace control, it is of course necessary to not only install well shaped, simply constructed and practically equipped control apparatus, but also to select its capacity with great care in accordance with the inherent characteristics of the furnace for which it is intended and for the furnace practice which is to be expected. It is therefore always advisable to study the construction of the furnace, chambers and flues, their respective cross-sectional areas and the length of path which the furnace gases are following in the circuit. With a balanced pressure condition in the hearth chamber, obtained by the proper adjustment of the Isley control apparatus, the furnace gases sweep over the charge or bath in form of a low hanging flame, which cannot fill the space provided and therefore avoids erosion of front and back walls and leaves an insulating atmosphere between the roof and the combustion blanket; in other words, there is a sort of blow torch effect.

A High Speed Furnace

A recent installation of the Isley furnace control on a 40-ton acid open hearth furnace, at the East Chicago plant of the Hubbard Steel Foundry Company, is illustrated by Figs. 1, 9 and 10, showing respectively the outside view of the venturi tubes, the fan and motor units in the enclosure at the bases of the tubes, and the switching and recording equipment on the charging floor. In this furnace a large variety of foundry heats are made, varying greatly not only in size but also in analysis desired and kind of material charged. The following is an example:

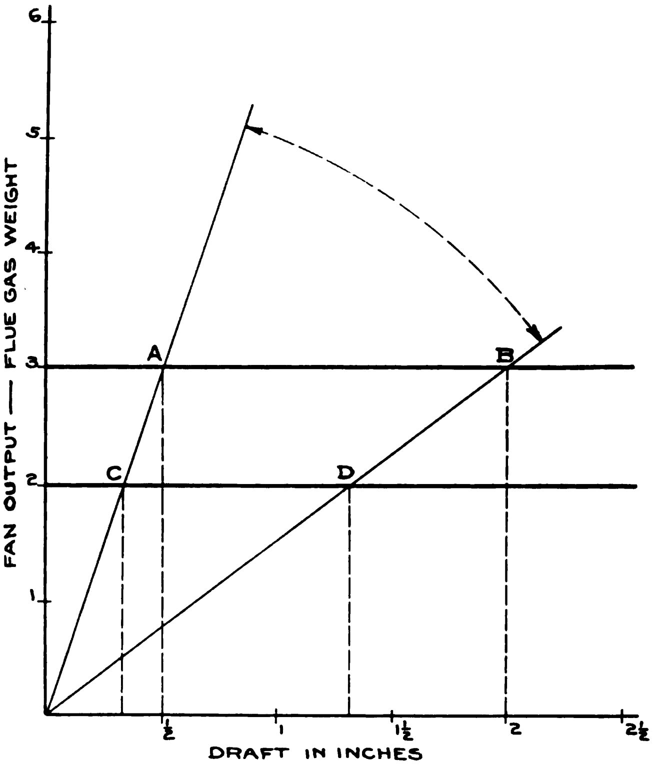


FIG. 4

Heat No. 43 was scheduled to tap 25 tons with a carbon content of .25 to .35 and manganese 1.50 per cent. In order to obtain this analysis using a ferro manganese containing 6 per cent carbon, it is necessary to reduce the carbon content in the bath as low as .10 to .12 per cent, the amount of carbon present in the ferro manganese being sufficient to raise the carbon content in the ladle to the desired points of .25 to .35 per cent. During the melting period of this heat, which melted in 3 hours and 40 minutes, 570 gallons of oil were used, or 22.8 gallons per ton. With the sharp flame produced under the Isley control, the metal became hot quickly and the first test fracture showed an estimated carbon content of .40 per cent. Having .30 points of excess carbon in the bath, 200 lbs. of iron ore were added and allowed to boil 30 minutes. The bath was then ravelled with a stirring rod and the first preliminary carbon test taken 47 minutes after the heat was declared melted. This test analyzed .15 per cent carbon. A second test was taken 1 hour and 5 minutes after the charge was melted and showed .12 carbon. The heat was then tapped out having consumed 170 gallons of fuel oil during the testing period, or 6.8 gallons per ton, making a total of 740 gallons or 29.6 gallons per ton from charge to tap. As stated above, this was a 25-ton heat in a 40-ton furnace, which combination, of course, increased the radiation losses in the hearth.

Large Number of Reasons for Good Results

The above is not an unusual performance in this furnace, and is cited here merely as an illustration of the results which may be expected from proper combustion control. The simplicity of design and manipulation of the Isley furnace control and its reliable function as a mechanical draft machine are features appreciated by the operator.

The apparatus is easy to install and requires practically no maintenance, occupies a minimum of space, permits of straight flues, is entirely independent of the furnace and building structure, eliminates cumbersome reversing valves as well as costly high stacks, has no water seals, no heavy dampers, and has a low initial

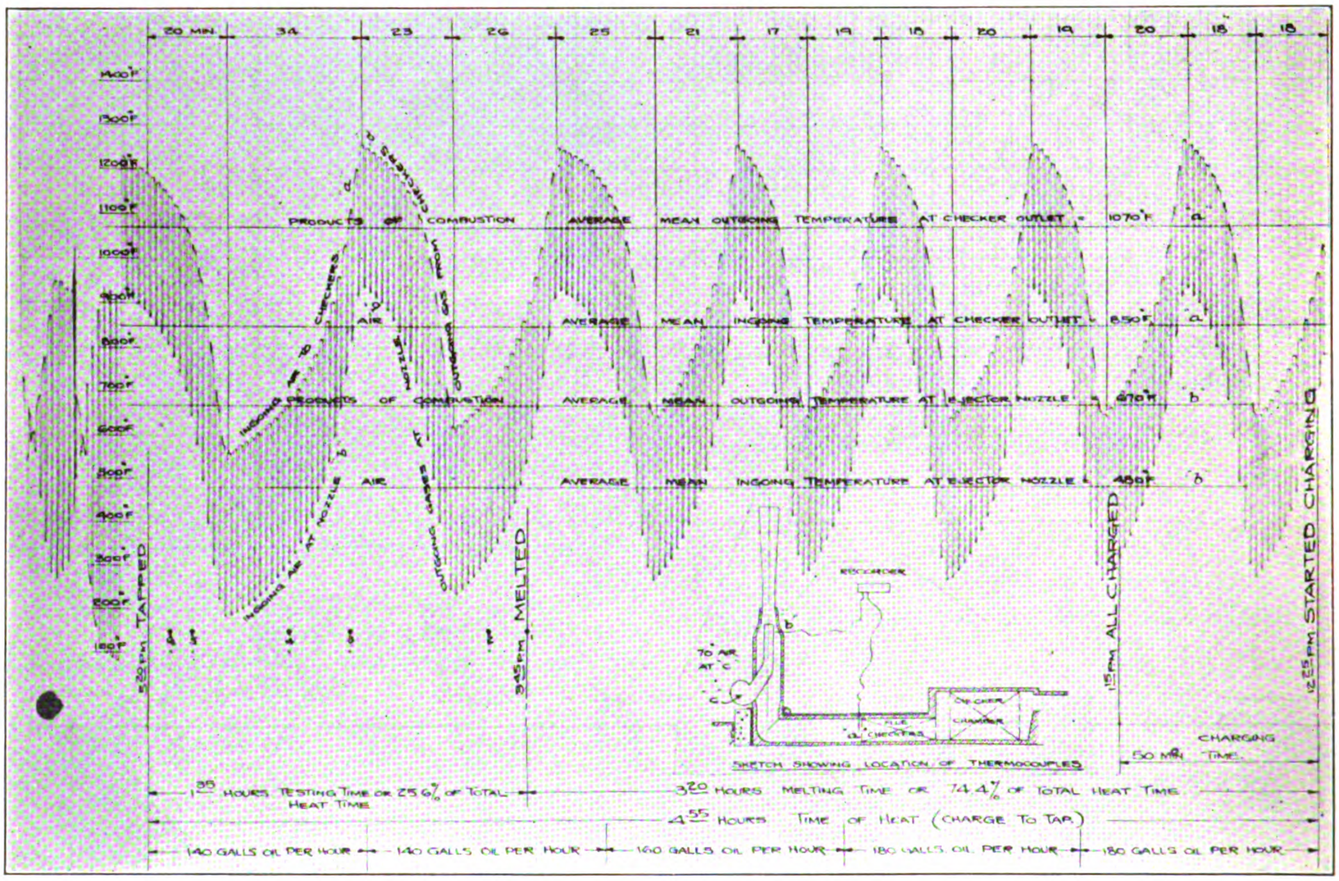


FIG. 5

HEAT No. 40

History of Testing Period

No. 1—3:45 p. m.—All melted.
No. 2—3:55 p. m.—200 ore.
No. 3—4:30 p. m.—Test No. 1, .40 carbon.
No. 4—4:45 p. m.—Test No. 2, .30 carbon.
No. 5—5:10 p. m.—300–50% silicon in furnace.
No. 6—5:15 p. m.—825–80% ferro manganese in furnace.

Final Analysis

.34 Carbon	.044 Sulphur
.80 Manganese	.050 Phosphorus
.300 Silicon	

Oil Consumption

Total oil consumed	800 gals
Tons charged	25 tons
Time melting	3 hrs. 20 min.
Oil consumed during melting	580 gals.
Oil per ton during melting	23.2 gals.
Time testing	1 hr. 35 min.
Oil consumed during testing	220 gals.
Oil per ton during testing	8.8 gals.
Oil per ton (entire heat)	32.0 gals.

Operating Time

Time charging	50 min.
Time melting	3 hrs. 20 min. or 74.4%
Time testing	1 hr. 35 min. or 25.6%
Time of heat	4 hrs. 55 min. or 100 %

Materials Charged

7500	Low Phosphorus Pig Iron
42625	Scrap and furnace additions
50125	Total charge.

cost. Its performance is not affected by weather and it has almost unlimited surplus capacity. By virtue of its extended regenerative character and tight construction, there is a minimum amount of heat lost in waste gases; highly preheated air is delivered to the checkers, which insures more uniform temperature in the latter between reversals; higher air temperature results in a sharper working furnace, making the heating time lower; through better combustion conditions in the hearth chamber, the charge is melted under reducing atmosphere requiring less pig iron burden; the tapping temperature is reached more quickly. All this makes for a decidedly increasing production, decreased fuel consumption per ton product, longer life of the furnace and thereby lower repair cost per ton of steel.

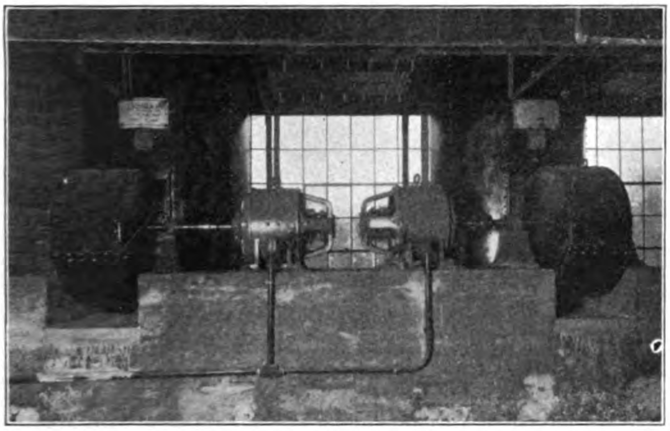


FIG. 6

It has been found that the rate of production remains practically constant from the beginning to the end of a furnace run, and some remarkable increases in furnace life have been reported. Installations of the Isley furnace control to date covering oil, natural gas and coke oven gas fired basic and acid furnaces, ranging from 10 to 100 tons nominal capacity and producing foundry castings as well as ingots. In a number of instances existing furnaces were equipped with this device without interrupting the furnace operation, as it is usually possible to prepare the new installation without touching the old flue, reversing valve and stack system, which is simply cut off when the control installation is finished.

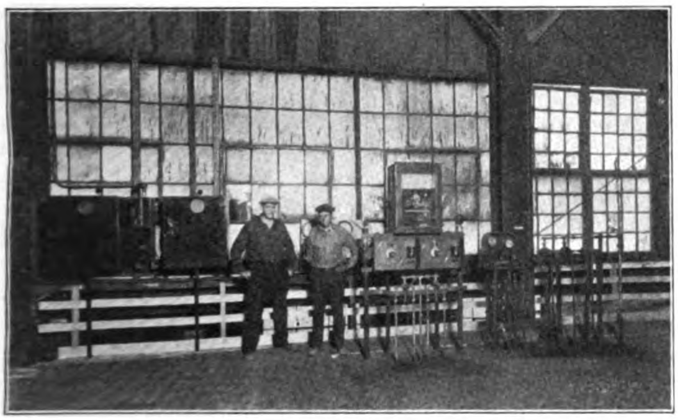


FIG. 7

Second International Conference on Bituminous Coal

Dr. Thomas Stockham Baker, president of the Carnegie Institute of Technology, in Pittsburgh, expects to spend six weeks in Europe during February, March and April of 1928 to organize plans for the Second International Conference on Bituminous Coal at Pittsburgh, according to an announcement from his institution. The first conference, it will be remembered, was held in November, 1926, under the auspices of the Carnegie Institute of Technology, and was attended by 1700 delegates and leading fuel scientists from 13 different countries. The second conference, which will be held under the same auspices, is scheduled for the week of November 19, 1928. President Baker's itinerary will include visits to scientists throughout Europe.

In connection with the preliminary plans being formulated by President Baker and his associates, it is further announced a definite decision has been made to include the subject of "Synthetic Fertilizers from Coal" in the program for the second conference. Other subjects to be considered will probably include the latest developments in obtaining substitutes for gasoline from coal, power from coal, low and high temperature distillation processes, smokeless fuel, gasification of coal, utilization of coal tar products, and coal in relation to the production of fixed nitrogen.

Formal letters of invitation to be officially represented at the 1928 meeting have been sent to the ambassadors, ministers and charge des affaires in Washington of the following countries: Argentine, Belgium, Brazil, Chile, Cuba, France, Germany, Great Britain, Italy, Japan, Mexico, Peru, Spain, Austria, China, Czechoslovakia, Denmark, Greece, Hungary, Norway, Panama, Poland, Sweden, Switzerland, Netherland and Roumania.

Morgan Engineering Company Establishes Record

A record has been made for consecutive orders for large capacity electric cranes by this company in October and November to date that is without parallel in the history of this company. Starting with orders for a few small cranes in October, our first large order consisted of one 175-ton ladle crane, three 50-ton standard cranes, and one soaking pit crane for the American Rolling Mill Company, Middletown plant. This was followed with an order for a 200-ton locomotive handling crane for the Canadian National Railways, the crane to be installed in their Stratford (Ont.) shop. The next order was for a 250-ton, special three-girder crane for the Bethlehem Steel Corporation for installation at their Lackawanna plant. This was followed by an order for two 75-ton cranes, span 120 ft. 0 in., for the McClintic Marshall Construction Company, one crane to be installed at Pottstown, Pa., the other at Rankin, Pa. The Continental Steel Company of Kokomo, Ind., were next with an order for a 125-ton ladle crane, one soaking pit crane and one low type open-hearth floor charging machine, all for installation at Kokomo. This order was followed by an order for a 150-ton and a 100-ton ladle crane. (We are not at liberty to divulge the name of the purchaser). Next came an order for a 100-ton ladle crane for the Youngstown Sheet & Tube Company, followed by a 75-ton crane for the same company.

Metallurgical Developments of 1927

Important New Advances Made During the Year in Blast Furnace and Foundry Practice and in Steel Plant Equipment and Operations and Rolling Mill Design

By STEPHEN GOODALE*

METALLURGY may be defined as the science of metals, and the art of producing, shaping, treating and combining metals and alloys for practical use. It includes a great variety of scientific material, and of processes and plant, and in nearly all of its branches is undergoing very rapid advancement, improvement and expansion. It is too large a field to cover in a brief review, and the attempt will be made here to mention briefly some of the more important developments which have come to the attention of the writer, and especially those which seem to have special value in their suggestiveness for future advances, rather than merely to list a considerable number of matters of progress.

The Blast Furnace Process

The iron blast furnace may be taken as the starting point for manufacture of nearly all of our iron and steel supplies. Progress in the scientific control of the smelting of iron ore in the blast furnace has been rapid. Extensive studies have recently been conducted by the United States Bureau of Mines, by the National Federation of Iron and Steel Manufacturers of Great Britain, and by others which have already yielded much very valuable information in regard to the chemistry and mechanics of the smelting operation, and some of these investigations are still being continued. A large mass of data has been published during the past year, the study of which will almost surely lead to further improvements in the conduct of the process and the quality of the product. It seems to be generally agreed that the quality and uniformity of coke available is one of the most important items in blast furnace operation, and for this reason the subject of coke has received very intensive study.

The cleaning of coal by washing, or by flotation, or a dry process before coking offers very good prospects for economy. It is estimated reducing the ash of coke by 1 per cent will cut the cost of pig iron by 20 cts. per ton. In addition to reducing the ash it is probable that the cleaned coal will yield a coke of materially better physical structure. Another big improvement in coke may be expected from the more general application of the so-called dry quenching of coke, which is merely slow cooling in an inert gas instead of quick cooling with water. The plants at Rochester and Syracuse, already using the slow cooling, report harder and less friable coke—results to be expected—and a very considerable economy in the way of steam produced from the sensible heat in the coke.

The theoretical chemistry of the blast furnace has been under considerable discussion, especially with reference to the formation and decomposition of alkaline cyanides in the hearth and lower portion of the stack, and the effect thereof on the fuel efficiency of the furnace. It seems very unlikely that the iron blast furnace will ever be relied upon regularly as a source of alkaline cyanides unless it can be shown clearly that the abstraction of a part of the bosh gas for the recovery of cyanide will result in improved efficiency of the furnace operation such as a saving of coke, or better iron. A much more promising method of fuel economy is the use of low grade blast furnace gas for the firing of coke ovens, as at the South Chicago works of the Youngstown Sheet & Tube Company, thus making more of the richer coke oven gas available for the open hearth furnaces or other uses for which it is better fitted.

The economies secured by uniform dry blast are fairly well known, but the early methods for drying it were too cumbersome and expensive. Drying the blast by adsorption by silica gel has been under trial for the first time during the year at the Wishaw works of the Glasgow Iron & Steel Company, Ltd. This method is far more simple and less costly than that of refrigeration for blast drying, and the figures so far available as to costs of installation and operation seem to indicate real possibilities for its more general adoption.

The Colorado Fuel and Iron Company, at Pueblo, Col., has had in operation for something over a year a Cottrell electrostatic precipitator for dry cleaning of blast furnace gas. The cleaned gas is reported to contain an average of .2 grains of dust per cu. ft.—or less if it is desired to reduce the rate of flow of gas through the units. The gas is cleaned without reducing its temperature, and the dust is recovered dry and easily handled. The total power used is reported as 80 kw., and the plant is stated to be giving entire satisfaction, including return on capital invested.

Sponge Iron

The large-scale production of sponge iron commercially seems to be appreciably nearer at hand than it was a year ago. Sponge iron is being produced by the Thornhill and Anderson process from ferrous beach sand at Kuji, Japan. The reduced material is concentrated magnetically, and the concentrate briquetted. These briquettes can be produced to sell profitably at $10 to $20 per ton. Different samples of sponge iron vary widely in grade and value; one grade is understood to be imported at present into the United States at about $40 per ton. A plant for making sponge iron is said to be in commercial production in Norway, and a similar plant is projected by the Canadian Iron Foundries, Ltd., for a low grade deposit of iron ore near Bathurst, New Brunswick. The United States Steel Corporation also is experimenting along this line very extensively at Lorain, Ohio. This low temperature reduction of iron ores offers great promise for application to low grade ores in which the iron minerals can be reduced to particles of metallic iron nearly or quite free of gangue minerals so that magnetic methods can be used to separate them dry and without melting. The sponge iron can be used for production of high grades of steel or iron, or can be used for precipitation of more valuable metals like copper or lead from their solutions in connection with leaching processes.

---

*Professor of metallurgy, University of Pittsburgh.

A great deal has been written during the past year about a number of foundry developments. Special emphasis has been thrown on better appliances for mechanical handling in every department of the foundry, thus reducing labor, and also on sand conditioning for re-use of old sand, and on synthetic sand, or sands made up by proper mixtures. With the development of malleable iron and the steel foundry, the use of gray iron has declined very much in relative importance. Another factor cutting into it is the application of welding, especially electric arc or resistance welding, in production work in manufacturing many machine parts from steel shapes welded together. For example, the frames for very large electric generators or motors are frequently made now by welding rather than in the gray iron foundry as formerly. For these and other reasons the mechanicalization of the iron foundry has become more and more vital in order to put it on a competitive basis and permit industry to retain the cheapness and other advantages of the use of gray iron.

A hot blast cupola has been developed by the Griffin Engineering Company, and has been in production use at the Griffin Wheel Company plant for over two years. In regular practice with cold blast at this plant about 262 lbs. of coke are required to melt a ton of iron, against which when using hot blast 195 lbs. are used. The heating of the blast is accomplished in a recuperative type of stove fired with gas withdrawn from all around the cupola stack below the charging floor. The following table of analyses and temperatures of the waste gas at the top of the cupola indicates something of the reasons for the success of the application:

	CO_2	O_2	CO	N_2	Temperatures: At side wall.	Center.
Hot blast cupola......	14.1	.5	10.1	75.3	580° F.	310° F.
Cold blast cupola.....	10.8	.4	15.6	73.2	856° F.	562° F.

Centrifugal casting has been successful in the commercial production of cast iron pipe now for some years, and Leon Cammen proposes to extend its use to the production of steel bars to be used as such or as raw material for rolling sheets, etc. It is claimed that considerable savings can be made over the cost of production of similar bars in the more usual manner.

The subject of permanent molds has again been under investigation for small shapes that are not too intricate.

Direct blast furnace metal is in use at the Fordson plant of the Ford Motor Company in making cylinder blocks. It is used in conjunction with cupola melted metal, a 400-ton hot metal mixer and two electric furnaces. With this equipment the iron can be secured for the blocks of very uniform analysis and temperature, and considerable quantities of borings and steel scrap utilized.

The Open Hearth

Open hearth developments have been no less important than those in the realm of the blast furnace. As the blast furnace is the most used means of producing a raw ferrous metal, so the open hearth is the most used means in America for producing our refined steels. The matter of fuel economy has been much to the fore in this as in other connections. The chemistry of the process also is the subject of continued study. The two open hearth conferences of the year under the auspices of the American Institute of Mining Engineers were of great interest and value to all those engaged in the industry, and they are constantly increasing in influence.

Mr. W. H. Fitch, of the Carborundum Company, has proposed the use of recuperators in open-hearth work, using relatively small regenerative chambers at each end of the furnace, with a common recuperator. With the more general use of high conductivity brick, such as those made of carborundum, and with the metals now available that are capable of withstanding high temperatures, interest in recuperator systems for fuel economy has increased very rapidly. The Donner Steel Company placed in operation in February last a soaking pit for ingot heating, using a recuperator built by the Chapman Stein Furnace Company instead of the usual regenerative system. It is hoped to secure a more even heating of the ingots with the new system, and about the same or better fuel economy. Several suggestions have been made also for the improvement in design of regenerators; one by Mr. Fred H. Loftus of checker brick shapes which will give a series of parallel walls held in place by staggered spacer brick, thus giving a better ratio between the heating surface of the brick and its total mass; and another suggestion from Germany of a special shape brick that accomplishes a similar object in a slightly different way, securing a series of vertical flues with a minimum of inactive brick material.

There has been much more widespread use of the refractory gun for making up bottom. Mr. H. A. Young, of the Allegheny Steel Company, Brackenridge, Pa., reported making up the two ends and back wall in eight minutes. Any operator who is at all skeptical as to the savings from quick repair and the resulting avoidance of cooling of the furnace would do well to read what Dr. E. D. Peters had to say some years ago in his "Principles of Copper Smelting," in regard to heat losses during charging of the older reverberatory furnaces for smelting copper ores. Open-hearth roof and port construction also have been studied especially during the year.

Electric Melting, Treating and Welding

There has been rather a steady advance than any very notable special developments in electric furnaces for melting iron and steel. Some 60 new melting furnaces have been built in this country, some, however, for export, and a number of them of small size for experimental work. The Pittsburgh Electric Furnace Company has applied to some of their units a top charging arrangement with certain new features. A number of older installations have been more or less revamped by replacing the original transformers and whole current supply system with new equipment of larger capacity. The newer furnaces are usually more generously powered than formerly, and higher voltages are usual for both the melting down and the refining stages.

The metal resistor electric furnace with automatic temperature control is becoming more and more generally used for heat treating of steel and other alloys, a number of plants of large size having adopted such equipment for all their heat-treating work. The resistor type is being adapted for higher temperatures such as are required for high speed steel by the use of globar resistors of carborundum.

Arc welding is being much more generally used, especially in the fabrication of machinery parts of somewhat complicated shapes which formerly were made of castings. Arc welding of framed structures is becoming more general; the quietness of this method of joining being much appreciated in many instances, and the savings in material being sufficient to be of importance.

Sheet Mills

The continuous rolling of sheets is one of the outstanding accomplishments to be noted, this being the most notable development in the rolling of sheets since the business started about 1750. The American Rolling Mill Company started the investigation of which this continuous sheet rolling is the outcome about 1913. They found it necessary to study the fundamental actions in thin sheet rolling much more thoroughly than had been done formerly. The investigation resulted in their building and starting to operate in 1923 at their Ashland (Ky.) plant a continuous sheet mill capable of producing 20-gauge sheets in widths up to 41 in., and at a rate of about a ton a minute. At the Columbia Steel Company plant, Butler, Pa., now a subsidiary of the American Rolling Mill Company, four high mills with roller bearings are in use, each mill being driven by an individual motor. Roller bearings have also been used for the backing-up rolls in a wide sheet mill finishing stand at the Lukens Steel Company. At the Lukens plant, a continuous annealing furnace has been installed for producing blue annealed or deep drawing stock, this furnace being equipped with Fahralloy rollers designed to operate at temperatures up to 1900 deg. F. The following figures give an indication of the savings due to use of roller bearings:

	Plain bearings.	Roller bearings.
17-in. roughing mill..............	30 kw.	13.5 kw.
Finishing mill	70 kw.	24.6 kw.

Plate Mills

Steel ingots weighing 63,000 pounds were recently rolled to 8¾ in. thick plates on the 206-in. Lukens plate mill to be used in making heavy flywheels. This 206-in. plate mill at the Lukens Steel Company was one of the first of the four high type built by the United Engineering and Foundry Company, of Pittsburgh, and is capable of rolling plates as thin as ⅜-in. in widths up to 16 feet.

The Knowles Tube

One of the most spectacular accomplishments of the past year, or indeed of any year, was in the developments that made it possible for Judge Gary, sitting in his office in New York City, to start the newly electrified Homestead structural mills with a mere waving of his hand over a bulb on his desk! Even Aladdin had to rub his lamp, but the genii of the 1927 Knowles improvement of the wonderful lamp do the bidding of the master at a mere wave of his hand. Wonderful genii, these electrons! The great beam mills at Homestead are worthy of such an inauguration to active duty. This new mill may perhaps be called a development of the Grey or the Sack's mill of earlier time, or something. The beams produced make possible great economies and improvements in building construction. There is the important difference between the Carnegie section and the Grey mill section that the latter has slightly tapered flanges instead of the constant thickness flanges from web fillet to edge of the former.

An interesting and novel design in individual motor driven table rollers has been developed recently in Germany, and is being put on the market in this country by the Schloemann Engineering Company. A similar idea was being worked on by Mr. Willis McKee independently, and he is now co-operating with the above concern in the development. The idea makes the shaft the stator of a motor of which the mill roller carries the rotor rigidly attached inside. Mounted at both ends in antifriction bearings well enclosed, the roll is thus driven at variable speeds between 130 and 3000 ft. per minute surface speed.

Chromium plating has recently been applied to lengthen the life of large oil stills by filling the still with the plating solution, introducing a suitable anode and rotating the still during the electroplating. It is now proposed to make the stills with a wall thickness of about 2 in., and to plate them before they are put to use to avoid the serious corrosion that has occurred in the unprotected steel. Chromium plating has become very much more generally used during the year, especially in automobile work. The use of cadmium also has increased very rapidly as a rust-preventing electroplated coating.

Metallographic investigation has continued very actively, and many very interesting and valuable papers have been published. A recent application of a modified X-ray tube to metallurgy is the bombardment of metals or alloys by a stream of electrons. Complete readjustment of crystalline structure has been brought about in this way; and it would seem possible that commercial applications may be found for the method.

The constitution and properties of hardened steel, the control of the character, constitution and properties of gray iron, the relationships between the magnetic and the other physical properties of steels, the prevention of fatigue failure by proper periodical inspection, the strengths of plain carbon and alloy steels, "creep," and other properties at elevated temperatures as required in modern boiler steam practice—these are just a few of the important subjects under investigation and upon which valuable data or research results have been published recently.

Death Calls Benjamin F. Jones, Jr.

Benjamin F. Jones, Jr., chairman of the board of the Jones & Laughlin Steel Corporation, and the leading figure in the steady development of that concern since 1891, died on January 1, after a brief illness. He had been at his desk as late as December 17.

The corporation of which he was the head was founded by his father, the late B. F. Jones, and grew from small beginnings to its present high place as second of the large independent steel interests in the United States, remaining unaffected by the combinations and consolidations that have taken place in the industry in the last 25 years.

Mr. Jones has been a dominant figure in the iron and steel industry of America for more than a quarter of a century. Like his father, he was a Republican in politics, staunchly supporting the party and its principles. He was born in the city of Allegheny, April 21, 1868; educated in private schools in Pittsburgh, in St. Paul's School at Concord and was a graduate of Princeton in 1891. He attended the First Presbyterian Church in Pittsburgh, and took an active interest in the work of welfare and charity. He was also interested in art and his collection of paintings is notable among the private collections in the city.

Progress in the Blast Furnace Field

A Cursory Survey of the Improvements in Furnace Design and Operation with Reference to Quantitative Production—Average Daily Capacity Increased

By O. R. RICE*

THE year has been marked by a diminishing number of active blast furnaces. In January, 210 coke furnaces were in blast; in June, 198; on November 30, 172. The list of total effectuals was decreased by three, 361 now answering to roll call.

Although the fortunes of the year have not been such as to encourage an indulgence in unexplored projects or embellishing accessories, one must not fall into the ironic impression that progress in the field has been confined to the art of skillful banking and graceful blowing out. On the contrary, the exigencies of the times have stimulated the demand for means to greater economies, and there has been a growing call for power plant and furnace rehabilitation surveys; an increasing inclination to use higher blast temperature than ever before; a more concerted effort to establish the answer to "what is good coke," and then obtain it; and a significant application of labor saving expedients heretofore viewed as effecting problematical or uninteresting economy.

The average daily pig iron output per furnace has advanced: 476 tons in January, 520 in June, 516 in November. This indicates that the cessation of operations has been among the stacks of smaller capacity. It is not entirely significant as evidence of the superior operating economy of the large furnace for the reason that the year has dealt none too kindly with the merchant iron trade, and the merchant stack is generally of smaller capacity than its steel plant counterpart. But there is a certain inference to be drawn from the fact that the furnace of larger rating has available a larger proportionate value of commerciable by-product, which if exploited, becomes a weighty influence in the net cost of producing pig iron. It is probable that the year's outstanding trend in the blast furnace field has been the increased emphasis laid upon the value of the chief by-products of the furnace: gas and slag; a discouragement of the open bleeder and the permanent slag bank.

During the past year numbers of furnace operators either have definitely arranged for the delivery of gas-raised electric power to the public utility lines, or have at least approached the consideration of such procedure with serious intent.

In other cases the utilization of surplus furnace gas has been turned into channels that are not confined to daytime or weekday operation. One of the most important departures in this respect is the policy of heating coke ovens with blast furnace gas. At least one large project of this nature is now under way.

The 5 P. M. opening of the bleeder valve is going the way of the single bell.

Economy in Use of Gas

Greater economy in the use of gas at the furnace itself, in order to enhance the surplus gas credit, has crystalized the heretofore somewhat casual interest in automatically regulated pressure burners for boilers and stoves, and has brought considerable attention to bear upon the subject of economically and appropriately conditioning the gas for its various individual uses. The drying and preheating of wet washed gas for stoves and boilers has received added impetus. The tendency to abandon the use of unwashed gas for any purpose has grown increasingly prevalent. In the southern furnace district, at least one quite definite commitment to the electrical precipitation method for gas cleaning is in evidence. In the same district the Dovel gas cleaner—a hot-wet method—has indicated its applicability to local conditions, and a recuperative auxiliary to the stoves, utilizing the stack gas to apply a preliminary heating of the cold blast, has elicited much interest.

The slag that formerly was consigned to the building of a monumental mountain at the rate of half a ton per ton of pig, now is drafted to aid also in enhancing the credit and suppressing the cost of pig iron. Although the practice of granulating slag has not increased, and has perhaps even diminished slightly, the reclaiming of crushed slag for ballast and concrete aggregate is in wide evidence, and has extended even to the slag dump of historic and long abandoned furnaces. The specifications of the concrete layer for aggregate, have more closely been harmonized with the slag control possibilities of the blast furnace operation. Means for improving the quality of slag for this purpose are being studied.

Saving Flue Dust

Accessory to the increased evaluation of the furnace by-products, have been the results arrived at in the reduction of the furnace flue dust output, and the more complete salvaging of that which is produced. In order to obviate a very considerable loss of metallic material incident to the production of large quantities of flue dust, quite costly equipment has usually been found necessary for rendering the dust reclaimable as a furnace charge. A tendency is seen toward enlarged stock-line diameters, and occasionally a proportionately smaller bell with a view to distributing the gas stream and so reduce its velocity. There are cases where the dust production has fallen-off in a ratio of 10 to 1, and the average dust factor in pounds per ton of pig is probably nearer 150 lb. than the 250 lb. figure usually accepted or conventional. The use of straight-line blast heat as against the peaked record of the "all heat" practice has contributed also to smoother furnace operation, and resultingly lessened dusting.

More complete recovery of the dust which does develop is accomplished in better designed dust catchers, and through the more universal application of sludge reclaiming means. Experiments for improving sludge reclamation have been conducted along the lines of continuous rapid filters.

(Continued on page 55)

---

*Metallurgical engineer, Freyn Engineering Company.

The POWER PLANT

Pulverized Coal at Huntley Station

Detailed Description of Power Plant of Modern Design—For Material the Author Has Used Freely Papers Delivered by H. M. Cushing and E. G. Bailey at a Recent Meeting of A.S.M.E.

By E. J. BILLINGS*

THE Charles R. Huntley Station of the Buffalo General Electric Company operates on the Buffalo, Niagara and Eastern Power Corporation system. Primarily the plant is the peak load and stand-by unit of the system. The base load is carried normally by the hydro-electric plants at Niagara Falls. The duty imposed on a plant of this type operating in conjunction with a large hydro-electric system is characterized by a wide variety of requirements. The station must not only be capable of handling base load at reasonable efficiency when system conditions demand, but it must also supply highly dependable stand-by service, which means periods of low load factor operation and the ability to pick up load quickly in emergency.

Previous to the design of the 1926 extension the station had been carrying only the peaks of the week-day load, keeping one machine in operation as stand-by during the nights, on Saturday afternoons, and on Sundays. This resulted in low annual station capacity factors. Station peaks were of very short duration, lasting not more than a few hours a year. These load requirements called for a minimum of investment and the operation of equipment at high capacities.

Up to the time of this extension, the plant contained twelve stoker-fired Babcock & Wilcox cross-drum boilers, each having 12,515 sq. ft. of heating surface, with 9,435 sq. ft. cast iron economizers. The maximum practical capacity of one of these boilers was about 130,000 pounds per hour actual evaporation.

Requirements to Be Met

Several outstanding requirements had to be met in the design of the 1926 extension which placed definite limits on the possible arrangements and selection of equipment. In the first place, sufficient boiler capacity to handle 670,000 lbs. of steam per hour under the steam conditions existing at the station had to be installed, with one boiler unit to spare. In the second place, the new equipment was to be placed in an addition to the then existing power plant. This led naturally to continuing the same floor levels and column spacings, resulting further in the selection of the same size boilers as those in the old plant and for which the building was designed.

To meet the above conditions, four boilers, one a spare, were added in the extension. These units are designed for a drum pressure of 320 lbs. gauge, and each has 12,515 sq. ft. of heating surface and 7,100 sq. ft. of superheating surface. Each unit was to have a maximum capacity of 225,000 lbs. per hour in order to meet the load requirements with three boilers.

In order to obtain this capacity without sacrificing too much efficiency, pulverized coal firing was selected in preference to stoker firing, particularly because of the quick starts and stops. The direct fired system of pulverized coal firing with the well type of furnace capable of withstanding high rates of combustion, was selected in preference to the bin system, because of the added cost of a coal preparation plant and the large furnace volume usually considered necessary at that time.

Because of many novel features in the design, one unit was rushed to completion to determine the limits of the well type of furnace. This unit had an 8-ft. square well furnace lined with Bailey walls. Trials on this unit brought about several important changes in the original design, with regard to the type of Bailey blocks used in the furnace wall construction, the method of obtaining turbulent combustion, the distribution of coal between burners and the use of preheated air in the mills in order to take care of very wet coal. As a result of these trials, it was definitely established that the unit as built is satisfactory for actual evaporations up to about 150,000 pounds per hour. Above this the life of the wall blocks is too short, but good efficiencies without smoke may be obtained up to 200,000 lbs. per hour actual evaporation.

Bailey Walls

As the design requirements necessitated a capacity of 225,000 pounds per hour from each boiler, the size of the well on the other furnaces of the three remaining boilers was increased to 16 ft. square and 7 ft. 6 in. deep. The four walls of the furnace are of Bailey refractory faced water cooled construction, which consists of Bailey blocks mounted on 3¼ in. tubes spaced on 6 in. centers. They extend down from the boiler to within a few feet of the basement floor. There is practically no brick exposed in the furnace. The furnace bottom is flat. It is composed of two courses of firebrick on steel plate. A 6 in. layer of burned dolomite dished up at the sides is spread over the brick. Below the furnace bottom is a plenum chamber for secondary air. The presence of this air prevents overheating the plate and structural steel supports. The coal and all air required for combustion are admitted through four burners, one in each water wall. These burners are offset 4 ft. from the center line. They are of the Calumet type, with the coal and primary air entering the furnace through a long, narrow central slot located between the tubes in Bailey wall. The secondary air enters through ports on both sides of this piping. These ports are at an angle of 45 deg. to the primary jets and are staggered so that the criss-cross action of the individual jets of secondary air will produce the turbulence so necessary to furnish the maximum quantity of coal in a limited furnace volume. Sheet steel housings surrounding the burners outside of the furnace confine the secondary air which comes from the plenum chamber under the furnace door. Adjustment of the secondary air at the individual burners is accomplished by a set of dampers in the ports.

---

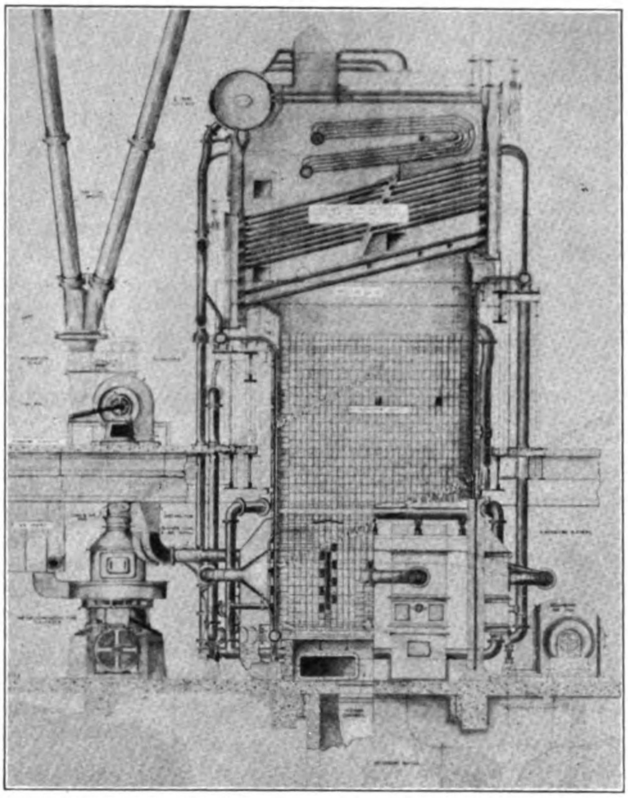
*Vice President, Fuller-Lehigh Company.

No attempt is made in the furnace to chill the ash before it settles. On the contrary, with this design of furnace it is important that the ash be maintained in a molten state until such time as it may be tapped out. This permits of higher rates of combustion per unit of furnace volume, and further it also permits the use of low fusion ash coal. The ash is tapped intermittently to a hydro-jet sluicing system, and no difficulty is experienced in handling it. When operating normally, the slag is tapped once per day, and 6,000 to 30,000 pounds are taken out in 30 to 60 minutes at one tapping. At lower rates of combustion it is not necessary to tap each day; the slag may accumulate and no trouble results from letting the furnace cool with a considerable amount of slag in it, because it will tend to melt when the furnace is again put into service.

Each boiler is supplied with pulverized coal by two 48 in. Fuller Lehigh pulverizing mills of the air separation type, rated at 8 tons of coal per hour. An exhauster draws the primary air through each mill, brings the pulverized coal with it, and delivers same to two burners located on opposite sides of the well furnace. This permits single mill operation as it is desired or required due to trouble on the other equipment. A high pressure preheater is provided for preheating the primary air. It is intended for use only when excessive moisture in the coal limits the output of the mills below the ratings desired.

High Boiler Rating Reached

These three boiler units have often exceeded 275,000 lbs. per hour actual evaporation for short periods of time. This is equivalent to a boiler rating of 625 per cent, based on the boiler heating surface only, or on a B. t. u. liberation in the furnace greater than 40,000 B. t. u. per cu. ft. per hour. No difficulty whatever is experienced in maintaining an actual output of 250,000 lbs. per hour indefinitely. These units have also proved themselves particularly valuable for making quick starts and stops. In the stoker fired section of the plant the shortest time in which a cold boiler can be brought up to header pressure is 90 minutes. The new boilers can do this easily in 40 minutes and, when urgently required, even this time has been reduced. In shutting down it is like turning off the gas under a kettle. The boiling stops almost immediately. This naturally results from the fact that the furnace is surrounded by water walls which do not store much heat. Losses due to popping of the safety valves after a sudden drop in load are thus minimized. Even though the setting has practically no capacity for storing heat above the temperature corresponding to the pressure, cooling below this point is very slow. There being no fire in the furnace when the boiler is out of service, it is practical to use tight uptake dampers. On the new boilers these dampers are split into four leaves, each controlled by the damper operating mechanism through coil springs. These springs take up the difference between the various leaves if they do not close exactly alike. With a tight damper and a tight setting it is possible to relight a boiler every twelve to fifteen hours for five to six minutes and have the boiler ready for service at any time within this five or six minutes or less. In the twelve to fifteen hours the drum pressure drops about 100 lbs. per sq. in. and 1,800 to 2,200 lbs of coal is required to bring it back to line pressure. It averages about 150 pounds of coal per hour to hold a boiler banked in this manner. Where the boilers are banked such a large percentage of time as they are at this station, the cost of banking is of considerable importance to the economy of the plant.



Sectional view of the pulverized coal furnace at the Chas. R. Huntley Station.

Even at high outputs there is no difficulty in maintaining 16 per cent CO_2 with nothing more from the stacks than the white smoke which is characteristic of good powdered coal firing. The flame from the four burners makes excellent use of the furnace volume, accounting, no doubt for the high CO_2 possible without CO, and for the high rates of combustion obtainable per cu. ft. of furnace volume.

Besides the wide range of capacities possessed by these boilers, which extends from 60,000 to 275,000 lbs. per hour, there is great flexibility possible in the way they may be operated. Frequently only one mill has been used, and in this case the secondary air has been supplied by either the other exhauster or the secondary air fan, or both. Using only one mill, a continuous output of 200,000 lbs. per hour has been maintained for twelve hours with an average efficiency of 83 per cent. It is also possible to operate both a mill and its exhauster out of service.

(Continued on page 55)

Auxiliary Fuel with Blast Furnace Gas

Powdered Coal Is Finding Increasing Favor as a Primary and Secondary Fuel in Conjunction with Gas—A Clear Description of the Methods of Burning Coal and Coke Braize

By F. H. DANIELS*

IN the iron and steel industry there is a very positive trend towards the abandonment of the various scattered steam engine drives and their isolated small boiler plants. Operating expenses, with so many small boiler plants operating small boilers at low boiler pressures were entirely out of proportion to the amount of power produced because of high labor costs, high maintenance expense and comparatively poor efficiency. The plants being constructed at the present time invariably are installing motor drives. These drives are deriving power from a large central power plant where large boilers and modern efficient equipment are used.

The electrification of the steel plant is bringing about a great saving in the amount of fuel burned, the maintenance and labor costs and general operating expenses. Invariably increased production results due to the mill speed remaining a great deal more uniform than was possible with the steam engine drive.

The average steel plant engaged in the production of pig iron and the manufacture of steel and the rolling of the various steel products, is favorably situated for the utilization of the modern steam driven electric generating plant. In a plant of this type blast furnace gas and in most cases coke braize, slack or screenings from coal are available for use as fuel. The main fuel, of course, is blast furnace gas and the boilers and furnaces are designed for its greatest utilization.

When there is a shortage in the blast furnace gas supply, during the furnace cast or when the furnace is down for changing tuyeres and so forth, other means must be employed for developing power. A great many plants are adopting pulverized coal as a secondary fuel; however, many still install separate boilers equipped with traveling grate stokers for the most economical utilization of the available coke braize.

F. H. DANIELS
President, Riley Stoker Corporation

If pulverized coal is decided upon for the secondary fuel the question, of course, arises whether to install a storage or bin system or a unit system. The unit system is best adaptable for use in the steel mill, and this paper will be devoted primarily in an endeavor to show where the preference lies.

Several years ago, before the development of the unit pulverizer to its present state of dependability, the practice in the central station plant of the public utility unquestionably favored the use of the bin or storage system of pulverized coal firing. The past few years have witnessed tremendous development in the unit pulverizer and at the present time the rugged construction of most of them assure complete reliability and dependability. The greatest evidence of this improvement in the construction of unit pulverizers is probably shown by the fact that big central stations as well as the bigger industrial plants are adopting the unit pulverizer in place of the storage or bin system. There is unquestionably a big preference in favor of the unit system at the present time. It only seems logical that the steel mill plant will follow in the footsteps of the central station plant of the public utility. This seems the correct course when all of the factors are considered accurately and minutely.

There is no particular advantage between the two systems as far as efficiency of performance is concerned; the question of preference is largely one of initial or investment costs. One way to get at the question is to compare the equipment required for a bin system as against that required for a unit system. The table of comparison on the following page will give some idea of the simplicity of the unit system as compared to that of the bin system.

With the unit system there is no need for drier, exhaust fan, cyclone separator, weighing tank and transport systems, pulverized coal bunkers, pulverized coal feeders, remote control system for transport lines, high pressure primary air fans and considerable piping, so that it is at once evident that a much lower investment will be required and a consequent reduction of the fixed charges over that with the bin system. The charges for maintenance on the large amount of equipment required with the bin system far exceeds that of the unit system.

---

*President, The Riley Stoker Corporation.

COMPARISON OF EQUIPMENT REQUIRED

BIN SYSTEM.	UNIT SYSTEM.
Raw Coal Bin	Raw Coal Bin
Dryer with Motor	
Dryer Fan	
Conveyor and Feeder Mill	
Pulverizing Mill with Motor	
Exhaust Fan for Pulverizing Mill	
Piping to Cyclone Separator	Unit Pulverizer and Motor
Cyclone Separator or Dust Collector	
Mill House Storage Bin	
Transport System—Usually Requires Air Compressor	
Boiler House Storage Bin	
Pulverized Fuel Feeders with Motor	Fan for Secondary Air and Motor
Feeder Blower with Motor	
Feeder Piping	Piping to Burners
Burners	Burners

In addition to the extra auxiliary equipment required for the bin system, it also must be realized that either a larger building will be required to house all of this equipment or else a separate building will be required for the bin system. This adds appreciably to the initial investment and the fixed charges in connection with the power house. The unit system can be installed in the boiler house without materially increasing it over the size required for burning blast furnace gas only.

The bin system has gained some favor for use with blast furnace gas fired boilers because less pulverizing capacity is required than when unit pulverizers are installed. This, of course, is due to the fact that the amount of pulverized coal is comparatively small over a week's run, and during the periods of no demand or light demand with the bin system, the pulverizer can be operated to build up a surplus supply of pulverized coal to meet the heavier demands, when the demand will exceed the capacity of the pulverizer. This condition, of course, lowers the initial investment of the bin system, lessening the difference in costs of the two systems in so far as initial investment is concerned, but by no means equalizing the two investment costs. The unit system, in spite of its greater pulverizing capacity, has a decided advantage.

It must be apparent to anyone who will sit down and make a comparison of investment costs and the consequent fixed charges, that the bin system with all of its auxiliary equipment will cost more to install. It certainly is far more complicated than the unit system, and if the two systems give the same operating efficiency, is it not the more logical to accept the simpler method? The unit system will gain favor in this field the same as it has in the public utility and general industrial field.

Another question which must be given consideration in any sort of a plant, and particularly in the steel mill plant, is the explosion hazard. It is quite generally agreed that the explosion hazard with the bin storage is far greater than with the unit system.

Flexibility of load must also be considered. If there is any preference in this respect, it is in favor of the unit system. With pulverizers using a small percentage of primary or carrier air and with short turbulent flame types of burners, a load range of from ten to one has been maintained. This range is sufficiently great to take care of any need which might arise in the steel mill plant. It is true that this load range could not be obtained several years ago; however, tremendous strides have been taken in the development of the unit pulverizer during the past two years, and this comparison is based on the better systems as now manufactured.

With the bin system it is necessary to rather completely dry the coal before pulverizing it. It is true that coal with a certain amount of moisture can be pulverized with the bin system pulverizers; however, if the coal is not completely dried all kinds of difficulty will ensue with the pulverized coal in the pulverized coal hoppers. If the coal is not dried, then the pulverized coal from the bin system pulverizer comes from the pulverizer containing considerable moisture. This results in a number of difficulties. The damp coal tends to adhere and does not flow freely. It will arch across the opening in the storage bin to the feeder, causing an entire stoppage of the coal to the feeder. Attempts to overcome this by use of agitators have been unsuccessful. When the arched coal is finally broken, usually by a man with a poker or long rod, flooding of coal through the feeder occurs due to the velocity with which it enters the feeder. This, of course, gives a flood of coal to the burner until the conditions become normal.

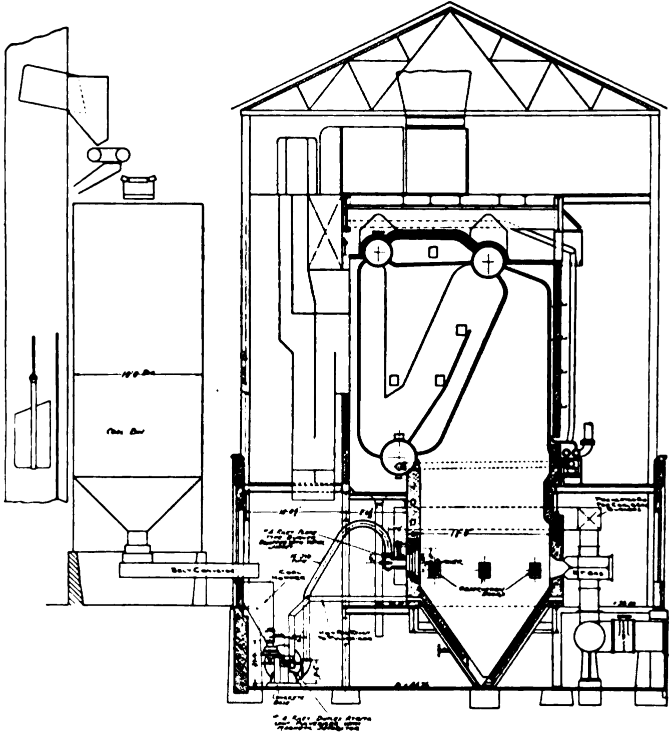
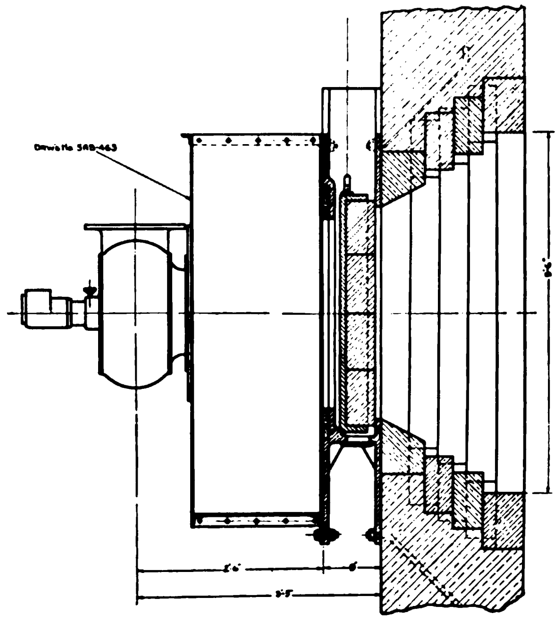


FIG. 1

Damp coal in a storage bin is also subject to heating and possible spontaneous combustion. With certain types of coal, fires have been numerous on this account.

Another disadvantage of storing damp pulverized coal is that it is very hard to keep it from sweating. This is merely condensation of moisture from warm, damp coal on to the cold surface of the bin. If the bin is made of metal, rapid corrosion occurs. All of these items affect the cost of operation, and must be given consideration when selecting the type of pulverized coal system to install.



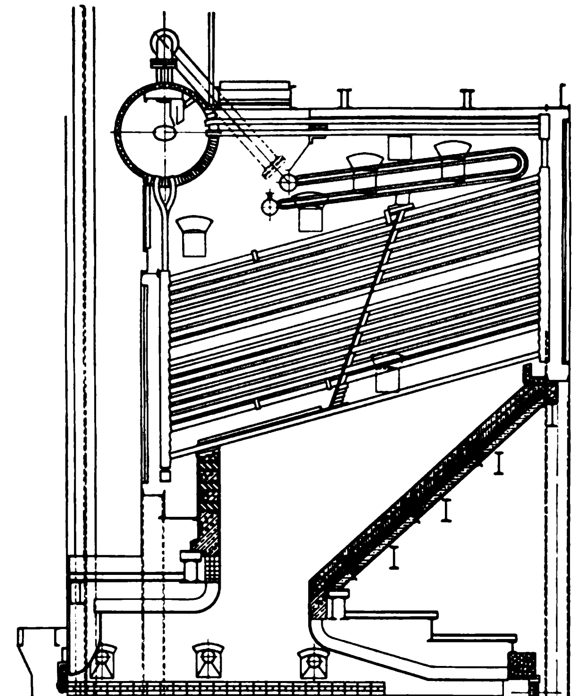


FIG. 2 (upper). FIG. 3 (lower).

The difficulties arising from using pulverized coal not completely dried with the bin system mentioned above emphasizes the necessity of completely drying it. The heat and power required in this process must all be charged back to the cost of operation. As this is not required with the unit system, from this standpoint the unit system is given a decided advantage over the bin system.

The bin system also requires a large amount of air per pound of coal for transportation purposes from pulverizer to cyclone and if preheated air, which is taken from a waste heat preheater, is used, it involves a large percentage of the heat recovery in the preheater which otherwise could be utilized in the boiler furnace. This heat is all lost, as it must be discharged to the atmosphere.

With the unit system only a small amount of air is used per pound of coal for transportation purposes, and any heat that might remain in the air after serving the purpose of transportation is returned to the furnace instead of being exhausted to the atmosphere.

In cases of extremely wet coal, with a unit pulverizer it is possible to take hot gases directly from the boiler furnace, temper these gases with room air and pass the mixture through the pulverizer. There is no loss of heat in this arrangement, over and above the actual heat required for drying purposes, other than the slight amount that is lost by radiation in the duct. The degree of drying required with the unit system is far less than that of the bin or storage system. With the unit system it is only necessary to dry the coal sufficiently to obtain the desired capacity from the mill and to allow the free flow of the pulverized coal through the pipes to the burners. There are cases where the moisture in the coal entering the furnace contained as much as 4 or 5 per cent moisture. Coal with this much moisture feels decidedly damp when held in the hand. If a bin system attempted to operate with pulverized coal leaving the pulverizer with this amount of moisture no end of difficulties would ensue.

The admission of moisture in the coal to the furnace certainly involves the least actual heat loss of any method of drying, and at the same time produces a real gain in boiler efficiency, particularly at higher ratings, as the moisture tends to reduce the furnace temperature and permits operation with higher CO_2 and less excess air.

Another advantage of the unit system over the bin system is in the regularity of feed. Tests on screw feeders such as used with the bin system have shown a variation of 35 per cent in the rate of feed over a period of 24 hours. The disc type of feeder used on certain unit pulverizers will not vary 5 per cent in 24 hours. A variation in coal feed, of course, will seriously lower the efficiency unless the equipment is controlled very accurately, changing the air supply to correspond to the variation in coal feed.

Certainly there is nothing inherent in a bin system which would give it an operating advantage over the unit system. The bin system was merely a necessity when the operation of the coal pulverizer was so undependable as to require a surplus or storage supply of pulverized coal to bridge over pulverizer break-downs or shut-downs. This condition no longer prevails. Reports from plants using both the bin and unit system invariably show higher operating efficiency with the unit pulverizer. When it is possible to obtain an average of 17.5 per cent CO_2 with no CO, without any signs of smoke from the stack and with an ash loss due to carbon in the ash less than 2 per cent, it does not seem possible for a bin system to better this performance.

Most of the earlier installations of pulverzied coal employed a long flame burner with a U-shaped flame.

Most of the installations being made at the present time employ the flare or short flame turbulent burner. A great many of the installations of pulverized coal in connection with blast furnace gas fired boilers still use the long flame burner. Why this particular type of installation should lag behind the public utility and general industrial field is quite hard to conceive. We feel sure that this field also will swing over to the unit pulverizer and the flare type burner which is proving so efficient.

Fig. 1 shows the general arrangement of a furnace designed to burn blast furnace gas, with pulverized coal as the secondary fuel. With this particular arrangement the blast furnace gas burners are located in the front boiler wall and flare type burners in the rear wall directly opposite the gas burners. It can be readily seen that the boiler house building is considerably smaller than would be required if it was necessary to install all of the auxiliary equipment required with the bin system.

When pulverized coal is used in connection with blast furnace gas fired boiler, some means must be employed to protect the pulverized coal burner when the boiler is being operated on blast furnace gas entirely. This can be done in two ways. Either water cooling surface can be placed around the burners or a fire brick lined gate can be installed which can be lowered over the entire face of the burner while the gas burners are being operated and lifted when the pulverized coal equipment is in operation. This latter method is particularly adaptable when no part of the burner extends beyond the outside face of the front wall. Figs. 1 and 2 illustrate these different methods.

When traveling grate stokers are installed for burning the available coke braize, the furnace design is the same as would be employed in any plant for the burning of the fuel. Fig. 3 shows a typical furnace layout for the burning of coke braize at the plant of the Toledo Furnace Company at Toledo, Ohio.

Progress in the Blast Furnace Field

(Continued from page 49)

Change in Furnace Lines

In furnace lines the trend is still directed to enlarged hearth and bosh. Inwall batter is variously between 0.9 in. and the conventional .75 in. per foot, aside from some few who have gone beyond 1.0 in. One new furnace went in during the year on a batter under ½ in., and has operated well with hard hematite ores on foundry iron.

Higher blast heats are in wider use and to greater degree than ever before. Although it is possible to find a lake ore furnace carrying 1800 deg. F. line heat, 1400 deg. is the more common picture and, occasionally, 1600 deg. Possibly the coke economy that might be anticipated with extreme heat is not always realized in practice.

The demand for higher wind continues, though some operators have found a limiting rate that is established by economy of operation on the given furnace.

There is a possible revivement of the gas blower compared with its somewhat quiescent status of a few years ago. This is in interesting contrast with the trend in Europe where a tendency toward turbo blowers has broken the universality of the long established commitment to the gas blower.

The long and earnest quest for a fundamental basis of coke quality has progressed very markedly, and several extremely enlightening reports by furnace operators and by the Bureau of Mines have gone far towards answering the question "What is good coke?" The coke operator, on his part, has entered into the problem with zest, and at several ovens the production of better coke consequent upon better separation, classification and handling of the same or even poorer coals has been successfully accomplished.

Decrease of Labor

The elimination of one man or even half a man per furnace, evaluated in terms of allowable investment in automatic equipment is viewed with increasing attention. Automatic bell dumping, interlocked with the skip operation, automatic stockline recorders, electrically driven mud-guns, automatically controlled mixing valves, and remote controlled stove-changing system, have either been accepted already as economical conditions rather than as luxuries, or are on the threshold of becoming so.

There are many who forsee that the returns on pig iron will never be restored to the pleasant margin of 10 years ago. The demand for high efficiency in furnace operation is not merely a transient one. Its permanence is not only established by the keenness of the present competitive field, but if one can read correctly the shadow of coming events, it is bound to a continuance by the advancing development of the direct reduction process for obtaining iron from ore.

The writer wishes to take this opportunity to acknowledge the kind assistance of many acquaintances in the blast furnace fraternity in extending useful and significant suggestions for this summary.

Pulverized Coal at Huntley Station

(Continued from page 51)

Fuel Burned

The fuel used comes from several mines in Eastern Ohio and Western Pennsylvania. The chemical analysis shows about 35 per cent volatile, 50 per cent fixed carbon, 10 to 12 per cent ash, and the remainder moisture. As received, the B. t. u. value of the fuel is about 12,500, the sulphur content from 3 to 4 per cent, and the fusion point of the ash from 1900 to 2000 deg. F. With this type of a furnace as described, it is unnecessary to be particular about obtaining coal with a high fusion ash. This permits the use of cheaper coal.

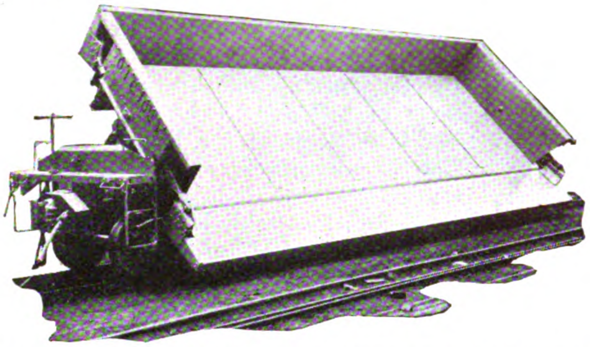
The distribution of air to the burners is so controlled that the flame is transparent throughout the entire zone of the furnace above the tops of the burners and even within the level of the burners the turbulence is so great that there is not that dense, dazzling mass of white flame that would be expected from the high rates of combustion that are produced in these furnaces.

Very complete tests of this installation at the Charles R. Huntley Station of the Buffalo General Electric Company have demonstrated that low fusion ash coal may be burned in comparatively small furnaces at high maintained efficiencies, and that the direct firing system permits wide flexibilities of operation with low cost per ton of coal handled.

WITH THE EQUIPMENT MANUFACTURERS

New Drop Door Car for Handling Slag

The economical handling of slag and other incidental waste of steel and blast furnace plants has become so great a problem that the appearance on the market of an air dump car of new design is an event worth noting. The Western Wheeled Scraper Company of Aurora, Ill., has recently designed what they call a Western Dual Side Pivot Air Dump Car. This car first was installed on the Mesaba Iron Range by Pickands, Mather & Company, where it has been attracting a great deal of favorable attention and its use at several steel mills has proved its adaptability for handling slag and other refuse.



The car is of the drop door type and the door when extended, reaches seven feet from the center of the track. The load is thus dumped clear of the track and does not require hand shoveling. It is an all-steel car of exceptional strength and simplicity of design. There is no locking mechanism. The cross sills of the body rest directly on the underframe draft sill, giving the car a low loading height, as well as eliminating possible sources of trouble. There is no chance for accidents due to accidental dumping or careless handling. Single stroke cylinders, operating at low air pressure, raise the bed in dumping to an angle of 50 deg., while dropping the door instead of raising it, leaves an unobstructed opening for the discharge of material. The dumping is both rapid and thorough.

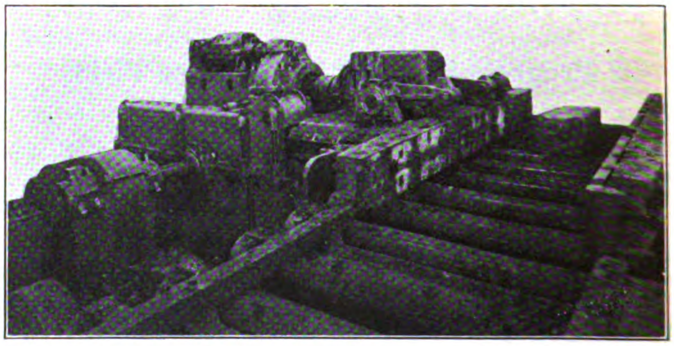
A New Type of Blooming Mill Manipulator

The Wheeling Mold & Foundry Company of Wheeling, W. Va., has brought out a new type of electrically operated manipulator. This manipulator has been in operation for about eight months at the Mingo Works of the Carnegie Steel Company at Mingo Junction, Ohio, on the 36-in. blooming mill. It was designed with the idea of overcoming so far as possible costly delays and shut downs in blooming mills which are often the fault of the manipulator. It is of the overhead type and special attention was given to protecting all moving parts from scale and enclosing these parts in oil tight casings wherever possible. As there are no parts under the table that require attention, accessibility is another feature. The stationary parts are made very heavy to withstand shocks while the moving parts are kept as light as is consistent with strength to attain speed in operation.

The mechanism works very smoothly and rapidly in turning the bloom. The design and construction are excellent and no repairs have been necessary in the eight months that it has been in service. It has operated both on square blooms and on slabs; and will handle down to a 4 in. x 4 in. billet, and it has edged up slabs as large as 8 in. x 34 in. The outstanding advantages are its speed, and its freedom from mechanical trouble under all service conditions, so that the mill is not hampered or retarded by the operation of manipulating or by failure of the apparatus.

Two motors working on the same gear reduction are used to drive each of the side guard push bars which are under separate control and the motors are so wired that these are given a quick return. The cushion for the lower push bar is on the center of the rack low in the frame while the shock of the motion of the upper push bar is transferred by a rocker arm to its cushion on the same low line of reaction. The push bars, with their gears, are enclosed in oil tight cases provided with suitable oil wells, and they run in the guides on rollers. Suitable guards and wipers are provided to effectively keep the mill scale from the working parts.

The important departure of this manipulator from other electrically driven devices of the kind is in the mechanism for operating and guiding the lifting fingers. This is driven by a single motor located in a fixed position above and in line with the upper push bar. The power is transmitted from a gear reduction through a sliding square shaft and a universal coupling to the crank mechanism. This latter consists of a disc rotating in two sets of roller bearings and carrying in a slot a ball joint which through the rotation of the disc swings a universal rocking joint connected to the crank shaft of the lifting arm. This disc and rocking joint are enclosed in an oil tight casing with provision for ready inspection. Limit switches are provided to stop the motor at the bottom of the stroke so that the fingers do not rise above the table rollers except during operation; for this reason the disc swings first one way and then the other way on alternate strokes of the finger arms which equalizes the wear on the entire drive.



The crank shaft together with its bearings and the crank disc mechanism, are mounted upon a bridge on the upper push bar above the side guard with an air space between, so that the warping and expansion of the side guard, which is provided with expansion joints, does not affect the free working of the shaft and finger arms. The cranks and finger arms are provided with lugs to prevent too much swing of the arms and the arms hang in front of hardened replaceable guide plates on the side guard so shaped as to take up the thrust of the bloom against the fingers. The finger consists of a stepped piece of hardened tool steel bolted to the arm, and the lower part of the arm is so shaped that the guide plate shoves it over to follow the rotating bloom in the operation of turning. This action also balances the moment about the center of the push bar.

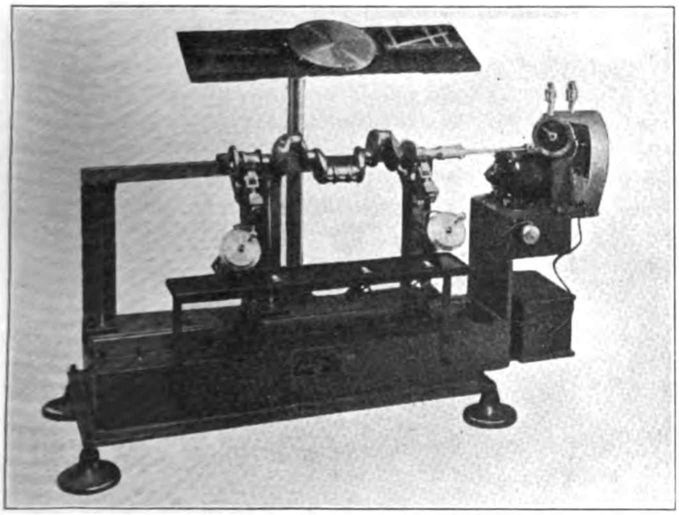
The side guard wearing slabs toward the mill are fitted with shear bolts so that, in case of accident, they may be knocked off without further damage to the manipulator. Provision has been carefully made for thorough lubrication and full protection of all wearing parts.

The manipulator is so designed as to be independent of the mill tables and so can be adapted to existing mills without making changes to the mill tables.

Centrifugal Dynamic Balancing Machine

The Tinius Olsen Testing Machine Company, 500 North Twelfth Street, Philadelphia, Pa., is featuring the Olsen-Lundgren Centrifugal Dynamic Balancing Machine made in various sizes to suit the requirement. It differs from previous models in that it provides two stands for holding the work and measuring and locating the centrifugal force caused by the unbalance.

The movement of the unbalance force is confined to a small minimum and the results are not affected by the speed, and the critical speed does not therefore enter into the calculation. For light work the standard speed is 265 r.p.m. and for heavy work half that speed.

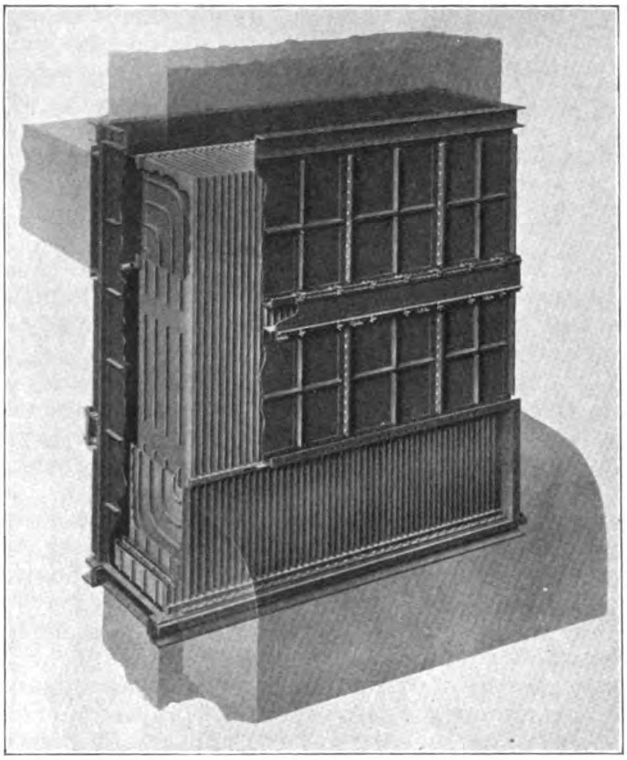


The operation of the test is rapid as the connection to the work is easily made and the readings in ounce-inches are taken direct in two planes on the work and can be transferred to other positions direct by accessory instruments. Any other specified graduations can be furnished on the dials and instruments. The machine is motor driven.

Recent Changes in the Design of C-E Air Preheaters

The following briefly outlines the recent changes made in the design of the C-E plate type Air Preheater:

Clean Out Doors—Access doors are provided in the heater casing which permit blowing the entire surface of the gas passages with steam or air lances.



Wherever possible, two such doors are provided in each heater located approximately one quarter of the element length from each end of the element so that the entire heating surface can be blown. Opposite these doors the spacer bars in the gas passages are cut away to form a lane through which a lance can be inserted. These doors can be readily opened and are small enough so that the heaters can be cleaned while the unit is in operation.

Welded Assembly Construction—In order to eliminate any leakage from the air side to the gas side of the preheater, the elements are welded to the casing by means of a sealing strip which also holds the elements in place and permits expansion of the elements relative to the casing. This construction also greatly reduces the amount of erection work necessary as there are no bolted joints to be lined up.

Arrangement of Gas and Air Openings—Although a number of arrangements are possible with respect to air flow through the heater, it has been found that what is known as the "S" flow design results in the most effective transfer of heat from gas to air. In this design, the air inlet and air outlet are located on opposite sides of the heater, and the baffles are so arranged that all lanes of air travel are of approximately uniform length, which assures an even distribution of air in all parts of the heater. The advantages of this construction, which derives its name from the fact that the air lanes are of "S" shape, warrant its use wherever possible.

TRADE PUBLICATIONS

"When Industry Says Stop" is the interesting title of a new booklet on Magnetic Brakes, issued by The Cutler-Hammer Manufacturing Company.

The book explains in detail the construction and operation of all types of magnet brakes—both for alternating and direct current. In addition it contains tables showing the exact size and type of brake for use with the various types of mill and crane motors.

A great deal of care evidently went into the writing of this book and it is worthy of a place in every readers' files. It will be sent free upon request to The Cutler-Hammer Manufacturing Company, at 136 Twelfth Street, Milwaukee, Wis.

* * *

The W. A. Jones Foundry & Machine Company of Chicago, who are manufacturers of Speed Reducers and Cut Gears, have issued a new and interesting Worm Gear Catalog, No. 35.

This company has been building these machines for a number of years and the publication describes clearly the advantages of worm gearing and details of design and construction.

The tabulations for horse power capacities of worm gear speed reducers and for both heavy duty and medium duty units and incorporates heat ratings for continuous operation for the two types of speed reducers.

The reading material and general arrangement of the catalog, indicates a thorough knowledge of the worm gear field with respect to the manufacturing and marketing of this type of gear. There are over 20 illustrations showing various applications of worm gear speed reducers in different classes of industries.

* * *

An interesting booklet has been prepared for the benefit of its stockholders by the General Electric Company. In addition to containing a statement of orders received, sales and earnings, there is brief description of each of its larger plants and the purpose to which they have been devoted.

* * *

The Elliott Company of Pittsburgh has issued their bulletin L on synchronous motors. The field of application on this type of motor is being constantly increased inasmuch as it is most reliable for service requiring a constant speed drive. The requisites for a satisfactory synchronous motor are that it be self starting, have high starting torque, be rugged in construction and have performance characteristics to meet the most exacting requirements. Following a general view of the synchronous motor, the principal mechanical and electric features of Elliott synchronous motors are individually listed and explained.

* * *

Bulletin No. 102, published by the Reliance Electric & Engineering Company, Cleveland, Ohio, is devoted to descriptive matter concerning fully enclosed fan cooled Reliance induction motors with ball bearings. The type of motor is for use in situations where exposure to iron dust, dirt and moisture is unavoidable. By the use of fans the motor windings and air gaps are kept clean and free from clogging. The many advantages of these motors are listed.

The Bristol Company of Waterbury, Conn., has lately published a pamphlet on recording instruments and their application in the power plant. The effect of recording instruments on power plant operating economy is strikingly pointed out and the manifold purposes and applications are briefly described. A table of much interest is printed in the back of the book under the title "A list of applications and instrument recommendations for power plants."

* * *

Boiler feed water heating by extracted steam is fully discussed in pamphlet 120, issued by Foster Wheeler Corporation of New York. Factors which govern the use, installation and construction are brought out in the article and adequate drawings and cuts develop more fully the points brought out in the text.

* * *

The DeLaval Separator Company of New York, has released a new issue of their magazine, "The DeLaval Centrifugal Review." The following articles compose the content of the magazine: Perfect lubrication important in the steel mill; Cincinnati Railway saves $2000 yearly in lubrication; striking improvement in turbine oil at Cahakia station; another proof of fuel oil purification advantages; oil purifier installations in steel plants.

* * *

Wm. M. Bailey Company, engineers, at 710 Magee Building, Pittsburgh, Pa., have issued three folders describing apparatus as follows:

The Thermal Expansion Goggle Valve for use on gas mains "opens easily and closes tight" and is therefore applicable to large gas mains carrying blast furnace gas or other fuel and noxious gases. Where a tight shut off from any position however inaccessible is imperative the goggle plate is easily thrown in or out by a pull on the chain and the closure or release of the seat is by thermal expansion or contraction through the agency of steam.

The American Safety Cinder Notch Stopper is designed for effective and safe operation at the blast furnace cinder notch and is strongly constructed and convenient in operation.

The Vreeland Pug Mill Equipment for handling flue dust and partially preparing it for sintering has a capacity of 60 tons per hour and pugs the dust with about two-thirds of the moisture required for sintering. It is applied directly to the dust catcher and discharges pugged dust into cars thus preventing the danger and damage resulting from the handling of hot dry dust.

* * *

A convenient text on blue print reading has been prepared by Thomas Diamond, associate professor of vocational education, University of Michigan. The matter is treated in two parts. Part 1 provides a series of mechanical drawings which the learner is asked to interpret by answering questions concerning the dimensions, construction, etc., of the objects shown. The drawings illustrate the common conventions of drafting, in progressively increasing difficulty and complication of form. Part 2 applies the principles taught in Part 1 in a series of dimensioned prospective sketches and incomplete projection drawings which the student completes by supplying missing views, dimensions, etc. The complete text is printed in pamphlet form and distributed by The Bruce Pub-
in pamphlet form and distributed by The Bruce Publishing Company of Milwaukee, Wis., and sells for 48 cents.

NEWS OF THE PLANTS

The Youngstown Sheet & Tube Company has under construction at the Campbell Works, Campbell, Ohio, a new power and boiler house; including in its equipment six 2000 hp. gas fired boilers with arrangements for the use of powdered coal when desirable, an 18,000 kw. turbo generator, three 60,000 cu. ft. turbo blowers and a 9,375 kv. amp. frequency changer.

* * *

The Carnegie Steel Company at the Carrie Furnaces at Rankin, Pa., has recently installed seven new hot stoves 26 ft. in diameter and 115 ft. high for heating the blast, and complete new hot and cold blast mains, gas mains and two field-type gas washers. The work was done by Riter-Conley Company, Pittsburgh.

* * *

The Central Steel & Iron Company at Harrisburg, Pa., are now using powdered coal on all reheating furnaces in the rolling mills. Other improvements include: A dolomite machine for making open hearth bottoms, a concrete floor with non-skid floor plates over the underground pipe lines in the 42-in. universal mill building, and the consolidation of the ingot storage yards for the 126-in. sheared plate mill and the 42-in. universal plate mill.

* * *

The Wheeling Steel Corporation has purchased the Riverside Works of the National Tube Company at Benwood, W. Va. The purchase includes the two Riverside blast furnaces with all buildings and trackage, the Benwood and connecting railroad and a site of 70 acres. The steel plant skelp mills and pipe equipment will be dismantled and scrapped by the National Tube Company. The blast furnaces have an annual capacity of 243,000 tons of iron, No. 1 furnace having been rebuilt in 1903 and No. 2 modernized in 1923.

* * *

A program of improvements was announced by the Gulf States Steel Company at its Alabama City, Ala. works, including four 900 hp. boilers and equipment, two 60,000 cu. ft. per minute turbo blowers, electric generators of 10,000 kw. capacity, condensers, water supply reservoirs and stand pipes and electrification of drives for the present rod mill. Dwight P. Robinson & Company, New York, will purchase and install this equipment. Completion is contemplated during the year 1928.

* * *

Donner Steel Company, Buffalo, has recently rebuilt the No. 2 blast furnace completely, increasing the capacity from 180,000 to 216,000 gross tons annually. The stock is now equipped with a McKee type top, bins and coke handling and screening units. The blowing equipment is an Ingersoll-Rand type turbo blower. A 25-ton Heroult type electric furnace has been added and a cold drawing department will be in operation early in the year.

* * *

Fifty-seven banks of Steere Cooling Coils have been purchased by the Youngstown Sheet and Tube Company from the Semet-Solvay Engineering Corporation. They will be installed in the company's coke oven plant at South Chicago. The coils will be 40 tubes high and 20 ft. long. They will handle the liquor produced from a carbonization schedule of 2,000 tons of coal every 24 hr. The coils will be sherardized to withstand corrosion. They will be of standard Steere welded construction. Distributing troughs will be equipped with leveling screws to permit adjustment and assure even water distribution.

* * *

The Newton Steel Company of Youngstown, Ohio, has recently contracted with The Rust Engineering Company of Pittsburgh, Pa., for two continuous sheet normalizing furnaces to be installed at their Newton Falls, Ohio, plant.

Each furnace is 155 ft. long and will normalize 160 tons of full finished sheets per day. The Kathner type disc rollers as made by the Duraloy Company will be used throughout the high temperature section of each furnace. The furnaces are so constructed that rollers may be easily inspected or polished by removing one or more sections of side wall and roof which are enclosed in one piece bungs of heavy cast iron section.

Except for being longer, these furnaces are of the same general design as the Kathner furnace which is working so satisfactorily at the Weirton Steel Company in their new strip sheet mill.

* * *

The Zenith Furnace Company of West Duluth, Minn., has awarded a contract to The Koppers Construction Company for the erection of a by-product coke plant. This plant will consist of 41 Becker type ovens and by-product plant and will have an annual carbonizing capacity of 350,000 tons of coal.

These ovens will have the feature common to all Becker type ovens, of being able to be heated with blast furnace gas or producer gas, as well as with coke oven gas.

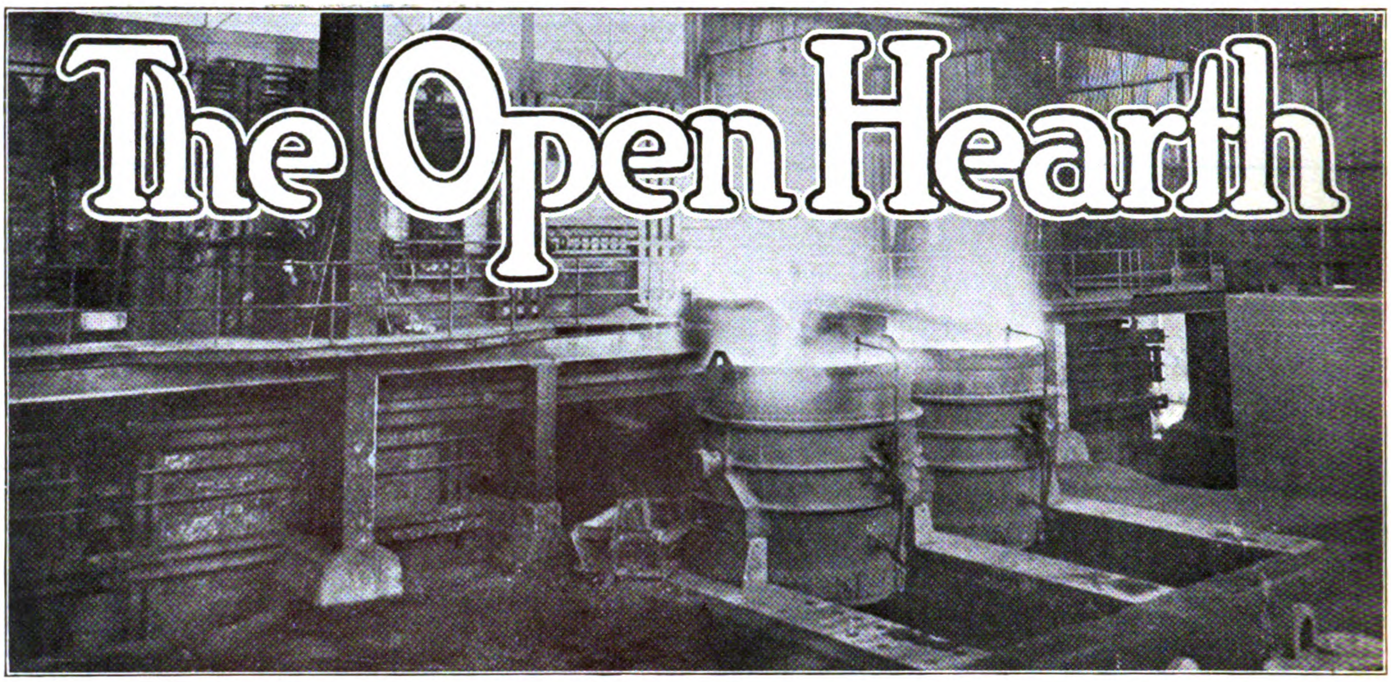
Telephone Rates Reduced

The most widely separated points of major importance in the iron and steel industry in the United States are now able to communicate by telephone for $8.00 or less, following a reduction in long distance rates put into effect throughout the Bell System on December 1. The rate between Buffalo and Los Angeles on a day station-to-station call, for example, is now $7.75, instead of $9.70, as under the old schedule. The corresponding night rate is $4.50.

The new rate reduction is confined to long distance service between points 400 or more miles apart, the greater the distance, the greater being the reduction. On the basis of the present use of long distance service, this decrease in the charges will save telephone users about $1,500,000 annually.

Many factors, both scientific and economic, have contributed to make this reduction possible. One of the most important factors has been the increasing volume of long distance traffic. The wholesale use to which the telephone is being daily put for the transaction of business between distant points has brought the cost per message down to a level where a substantial saving to the user can be effected.

The Open Hearth



George R. McDermott, assistant chief engineer of the Illinois Steel Company, has accepted the position as vice president and general manager of The Chapman-Stein Company, thus relieving Mr. N. L. Daney, formerly general manager, who has found it necessary to devote more of his time to The C. & G. Cooper Company, of which he is a director and treasurer. Mr. Daney will continue as secretary and treasurer of The Chapman-Stein Company and hopes to maintain a contact with his many friends in the steel industry.

Mr. McDermott has had a thorough engineering training and a wide experience in the steel industry. He was graduated from Cornell University in mechanical engineering in 1905, then served an apprenticeship with the General Electric Company, specializing on steam turbines. He afterwards returned to Cornell University for advanced work, during which time he instructed in thermodynamics in the college of engineering.

Later he became associated with Westinghouse Church Kerr & Company, now the Dwight P. Robinson Company of New York City, as a field engineer. He has been employed since 1913 by the Illinois Steel Company, South Works, where he has held the position of steam engineer and of late years assistant chief engineer.

Mr. McDermott has been active in a number of the technical societies notably the Association of Iron and Steel Electrical Engineers, combustion division, and the American Society of Mechanical Engineers. He has contributed many technical papers on various phases of the steel industry. Probably his greatest contribution was his paper entitled "Thermal Efficiency and Heat Balance of an Open Hearth Furnace," which was presented jointly by Mr. McDermott and Mr. C. L. Kinney, Jr., before the American Iron and Steel Institute and was awarded the Sir Robert Hadfield prize, which is given by the American Institute of Mining and Metallurgical Engineers.

* * *

Mr. I. F. Baker has been promoted to manager of the Far Eastern Department of the Westinghouse International Company. He comes to his new position from Japan, where he was managing director of the Westinghouse Electric Company of Japan, president of the American Merchants Association of Tokio, and acting president of the American Association of Tokio. His new offices will be in New York. Mr. Baker is a veteran in the Westinghouse Company, having combined his various experience into a broad acquaintance with the company both in America and abroad.

* * *

Eugene A. Balsley was elected vice president in charge of operations of the Wheeling Mold & Foundry Company, Wheeling, W. Va., at a recent meeting of the board of directors.

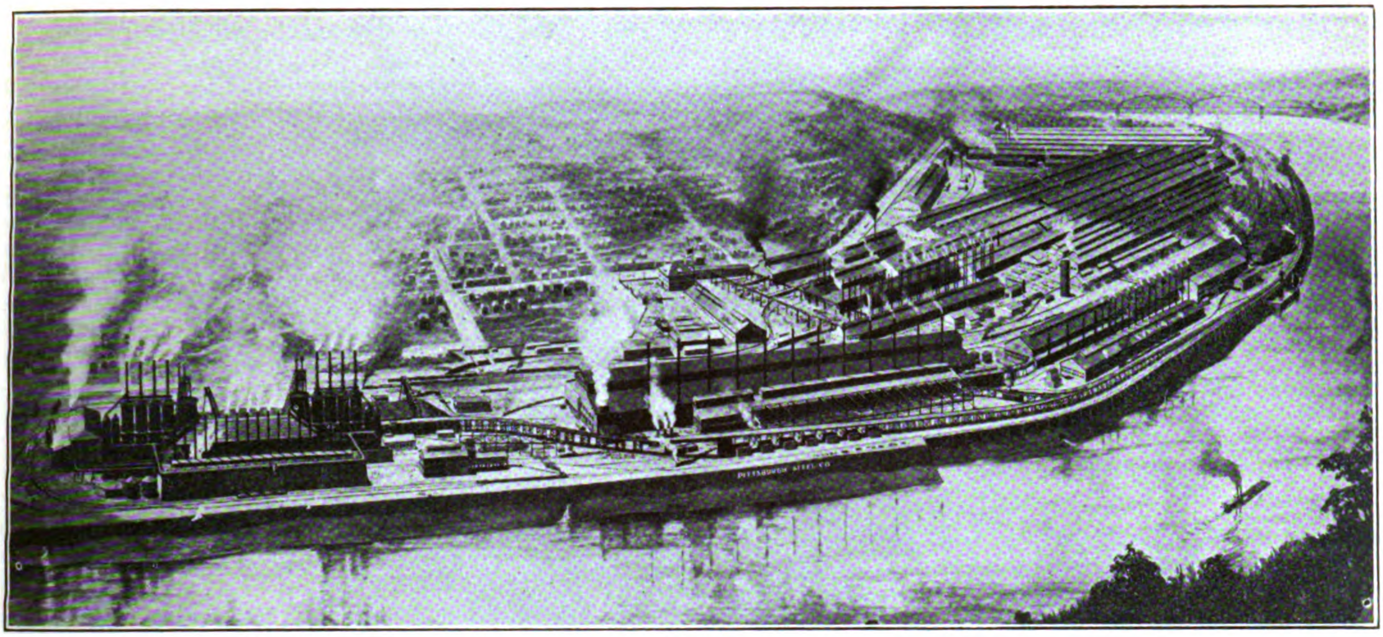


FIG. 1—General view of the Monessen Plant, Pittsburgh Steel Company.

The Plants of Pittsburgh Steel Company

A Description of the Plants, Equipment and Methods of Operation —Wire Plant and Tube Mills of Especial Interest, as Well as Equipment for River Transportation

THE opening years of the 20th century were years of unusual activity in the steel industry, for in that period there were very material changes in the economic structure of the industry. These changes were brought about not only by the desire to effect economies in organization, but also by improvements in the art of production. The effects were far reaching in that mergers resulted and expansions to many individual plants were made.

On July 3, 1901, the Pittsburgh Steel Company was incorporated under the laws of Pennsylvania, the founders being Wallace H. Rowe, Edwin Bindley, John Bindley, Willis F. McCook and Emil Winter. These men saw the great future of the steel industry and are responsible for the company's inception and its growth and development into the largest independent manufacturer of wire products in the world.

The first plant was built at Glassport, Pa., and rolled its first product in 1901. The equipment consisted of two hoop mills, a 10-in and an 8-in., making hoops, bands and cotton ties. The yearly capacity of this plant was 30,000 tons.

Shortly after the Glassport Plant was put on production, plans were completed for a wire mill. A large acreage was purchased at Monessen, Pa., and construction was immediately commenced. These plans called for a rod mill, a wire mill, galvanizing department, nail mill, fence department and other lines of wire products. Production from these mills got under way late in 1902.. Demand for additional tonnage soon was developed and additions were made, as necessary, to satisfy the demand.

During busy years in the steel industry it was found difficult to obtain billets on the market to fill the requirements of the wire departments and after many efforts to obtain a dependable source of supply, the directors of the company decided to build an open hearth department and blooming and bar mills to insure the supply of billets.

In 1907, eight 65-ton open hearths were built, a 46-in. 3-high blooming mill, a 2-stand 3-high 28-in. billet mill and a Morgan continuous 18-in. mill.

With this added equipment the company accomplished its purpose and was not dependent on outside supply of 4 x 4 billets to operate the finishing departments. The control of the steel supply was further augmented in 1913 by the erection of two 600-ton blast furnaces and the acquisition of partnerships in several mining companies to assure their ore requirements and the operation of their blast furnace.

In 1917, it was apparent that more open hearth capacity was necessary and money was appropriated for four additional open hearth furnaces, which when completed, gave a production of 60,000 tons of ingots per month.

In 1919 the coal and coke properties of the Harry W. Brown Company were acquired, giving the company their coke requirements and coal reserves for over 25 years. Having strengthened the position of the company in materials and equipment to insure a supply of steel for their products, the next plan was for broadening out and adding to the finishing departments. In 1921 the National Steel Fabric Company was acquired. This company manufactures concrete reinforcing fabric in the shape of welded wire mesh, and various types of building fabric for walls, ceilings and floors.

In 1925 the Pittsburgh Steel Products Company, manufacturers of seamless tubes was purchased, having plants at Monessen and Allenport, Pa. With the acquisition of these two companies it has been given an outlet for its surplus steel capacity and also served to diversify its products.

From an annual tonnage of 30,000 tons to a capacity of 600,000 tons of steel products per annum is a progress that the Pittsburgh Steel Company might well be proud.

This brief description of the growth of the company is a natural one, starting with a finishing department, working back with equipment to produce billets, then the installation of open hearths, followed by blast furnaces, ore reserves and coke and coal properties.

It will be of interest to give a brief description of the various departments of the Pittsburgh Steel Company, describing the equipment and the methods of operation.

Blast Furnaces

The two blast furnaces proper and their various departments were designed by Garrett & Cromwell Engineering Company and built by William B. Pollock Company. When erected the furnaces were identical in design, with a hearth dimension of 16 ft., 22 ft. 6 in. bosh and a 90-ft. stack. Numerous changes have been made in the lines of the furnaces since their installation. No. 2 furnace now has an 18-ft. hearth and with this change has increased its average production from 550 tons per day to 630 tons per day. The average tonnage per furnace is about 600 tons per day. The ore yard has a capacity of 250,000 tons which is ample to carry the furnaces through the months of closed lake navigation. A movable car dumper of the Wellman-Seaver-Morgan type dumps the ore into the ore yard, handling approximately 200 cars of ore per day.

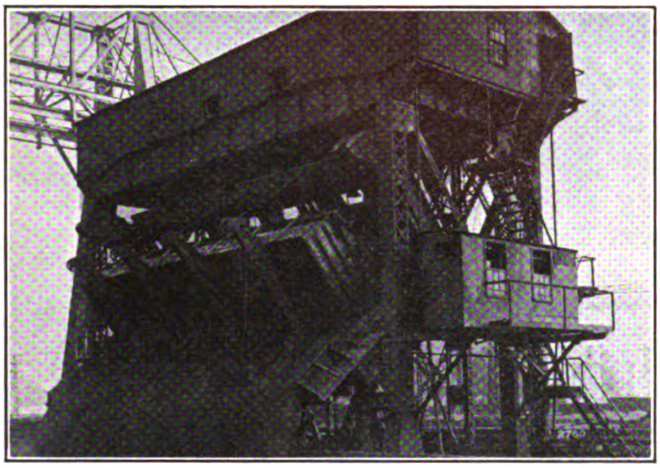


FIG. 2—Electric movable car dumper.

Two gantry cranes running the length of the ore yard serve the ore bins with various grades of ore. These bins in turn dump directly into larry cars and are taken to the base of the furnace skip hoist where they are dumped into the skip.

Each furnace has a separate coke bin with a capacity of 800 tons. A novel arrangement is installed for filling these coke bins. The coke is produced at the company's coke plant at Alicia, where it is loaded by belt conveyors into a self unloading barge of 1400 tons capacity. It is towed to the Monessen Plant and docked at the coke wharf. The barge is built with hoppers, which discharge the coke on belt conveyors running the length of the barge. These belts discharge on a cross belt that carries the coke to another belt conveyor that delivers the coke to the furnace bins. As a precautionary measure, the bins may be filled by dumping railroad cars placed on a trestle over the bins, in case of break down to the conveyor system. At the base of the coke bins revolving screens separate the fines, the metallurgical coke dumping directly into the skip and the fines are loaded in cars to be rescreened. The fines from this operation are used in soaking pits and the larger coke put back in the blast furnaces.

The blast furnace gas is washed for the stoves and the excess gas piped to the blast furnace boiler house in its raw state. All the slag produced at the blast furnace is granulated. Two granulating pits are adjacent to the furnaces, the slag is run to these pits and as it pours into them the stream is sprayed with water which breaks up the slag in a granulated form. These pits are emptied into railroad hopper cars by means of clam shell grab buckets, and are moved to the railroad for disposition.

Since economical handling is largely dependent on plant layout great care was exercised in properly locating the furnaces and accessory equipment. Furnaces No. 1 and No. 2, together with their stoves are placed on the same center line and adjacent to the boiler house. This layout makes the plant compact and gives a flow of a most direct pattern. The furnace arrangement also affords a further advantage in that it makes possible locating the casting floor of both furnaces under one roof. Moreover ample space is provided as storage space for small tools and cast house material. Under this same roof a small iron foundry has been placed for the casting of any spares which may be required at any of the plants. The iron for this foundry is obtained by diverting the stream of metal from the main runner and allowing it to flow into a small ladle placed in a pit at the end of the branch runner. When it is desired to fill this ladle a dam is placed in the main runner at the point where the branch leaves it, and after the ladle is filled the dam is removed and the metal passed again into the main channel. Three sintering pans are used in sintering flue dust which have a monthly capacity of 3500 tons. An electric engine delivers the molten metal to the open hearth mixer, a distance of only 600 ft. This short distance is a decided advantage as there is no sculling of iron and the life of the iron ladles is greatly increased. A 600-ton metal mixer at the entrance to the open hearth receives all metal going to the open hearth furnaces and a pig casting machine is adjacent thereto, which pigs any excess metal over the requirements of the open hearth department. The arrangement is such that when the metal mixer is down for repairs the metal can be taken from the iron ladles direct to the furnaces.

Open Hearth Department

The open hearth department consists of twelve 65-ton furnaces tapping on the average 93 tons per heat. The building proper is a two level type, the charging floor level and the stock yard level being the same, and the pit level sufficiently low to allow ample clearance for tapping of heats into the ladles.

The furnaces are fired by producer gas, each furnace having 3 Hughes producers, having automatic feeds, pokers and ash plows. Each producer has a capacity to gasify 1600 lb. of coal per hour.

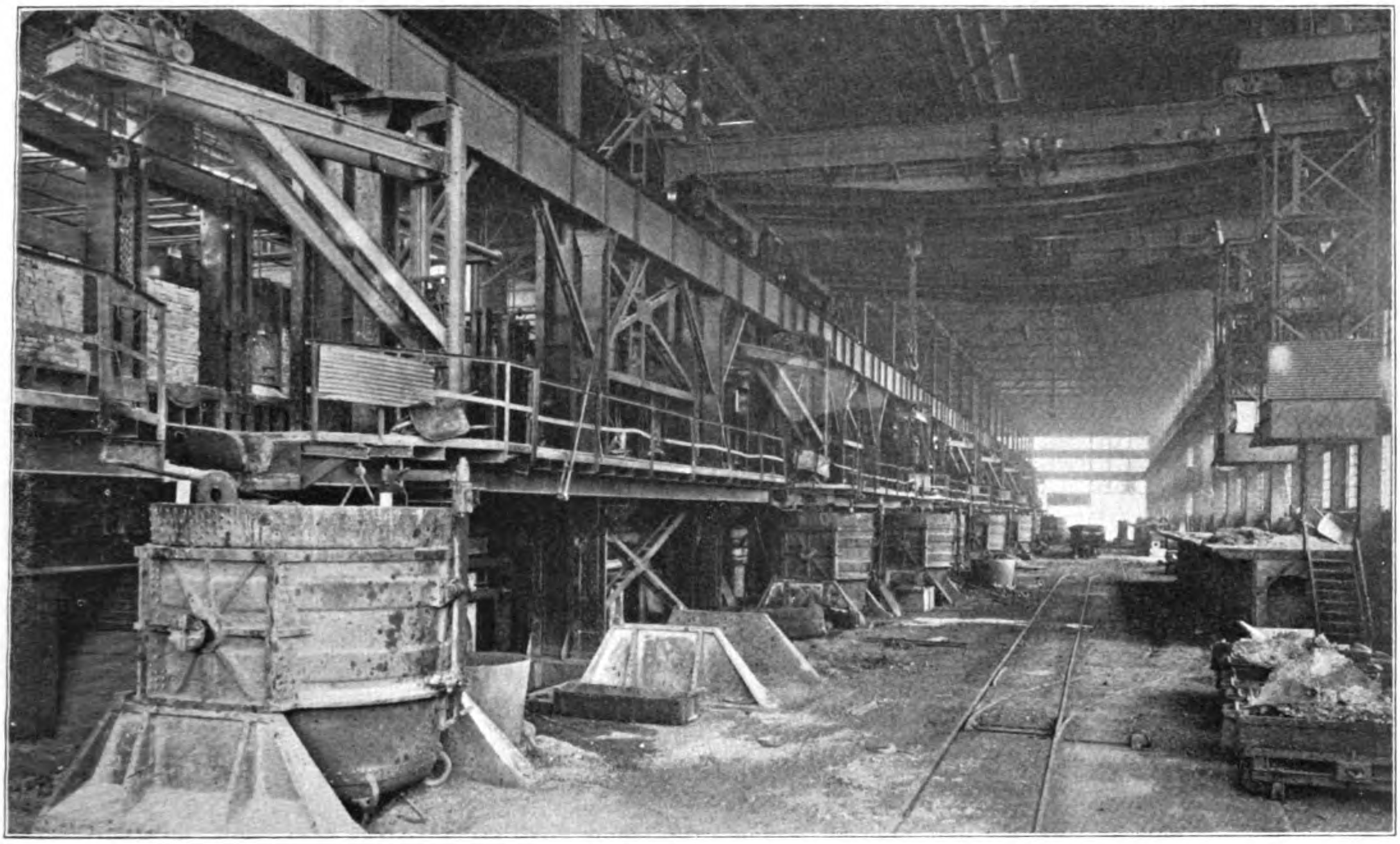


FIG. 3—Open-hearth furnaces, Monessen Plant.

The overall dimensions of the furnaces are 70 ft. 5 in. by 21 ft. 3 in. and the dimensions of the hearth 35 ft. by 15 ft., giving a hearth area of 525 sq. ft. The square feet of hearth area per ton of rated furnace capacity is 5.65 sq. ft.

The gas producer house is immediately back of the charging floor and back of the gas house is the stock yard. The stock yard has low level tracks for receiving the stock in railroad cars. The stock is loaded in charging buggies which run on a platform which serves as storage tracks for loaded charging buggies. This platform has 5 entrances to the charging floor which enables the stock to be placed for charging at all times. The pit practice in this department is equipped for top and bottom casting of standard ingots and a special pit for pouring small round ingots for the manufacture of seamless tubes made by the Pilger process. A small steel foundry is located in the pit for making mill castings. The pit is served with 3 ladle cranes and 2 auxiliary cranes for stripping bottom cast ingots and setting up of molds for bottom pouring.

Many grades of steel are produced in this shop; low carbon heats for wire products, special tube steels of low and high carbon, copper and alloy steels. A forged test is used in testing the quality of the steel and to estimate the carbon content of the bath. An electric trip hammer is installed on the charging floor and the standard test is forged to a ½-in. bar, broken and examined. From experience this test gives a more reliable estimate than the regular cast test. Carbon heats of .40 to .50 are tapped on these tests without laboratory checks and the results obtained are very accurate.

Pyrometers are used on gas producers which give the gas makers a knowledge of the conditions of their producers at all times. Ore and limestone bins are arranged so that buggies can be loaded by means of gates at the base of the bins, eliminating loading by grab buckets.

A calcining plant burns all the dolomite for the open hearth and burned lime is also made for special heats.

Safety has become a slogan in the department. Many rules and devices are used for the prevention of accidents. Tapping hole guards, guard rails, warning signals and a very thorough inspection of cranes and ladle trunions are some of the methods employed in accident prevention.

Blooming Mills

The blooming mill is a 3-high 46-in. mill which rolls a 19 x 22 ingot to a 7¾ x 7¾ bloom in 9 passes, designed by Mackintosh-Hemphill and driven by a 3500 hp. engine made by Southwark Foundry & Machine Company. In a line with the blooming mill is a 2-stand 3-high 28-in. billet mill which breaks down the 7¾ x 7¾ bloom to 6 x 6 or 4 x 4 billets in four or six passes. This mill produces 4 x 4 billets for a Garrett rod mill and for customers billets. Transfer tables from this mill permit further reduction of the bloom to rounds, small squares and slabs. This work is done on a 6-stand 18-in. continuous Morgan bar mill. The range of product on this mill is rounds from 3¼ to 5½ in. and small squares from 1½ in. square to slabs 7 in. x 3 in.

Rod Mills

Two types of rod mills are used for making rods. The first installed was a Garrett mill which rolls a 4 x 4 billet into rods 7/32 in. to 5/16 in. The mills have seven continuous roughing passes, three chilled iron passes and eight looping passes with repeaters on the oval side. This mill has an average capacity of 525 tons per day, with three continuous heating furnaces of the pusher feed type fired by producer gas. Five strands are in the mill at one time which give the mill the high tonnage. The rods when finished are fed into reels where they are coiled. These coils are pulled on a belt conveyor and are loaded on buggies ready for shipment to the cleaning house.

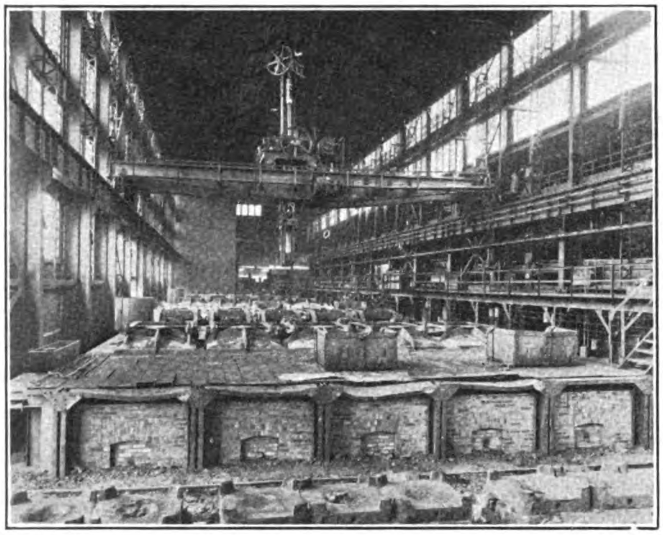


FIG. 4—Soaking pits.

The No. 2 rod mill is of the Morgan type which rolls rods from 7/32 to ½ in. This mill is made up of 16 passes. Its daily production is 425 tons, having two strands in the mill at one time. This mill uses 1¾ x 1¾ in. bars 30 ft. long and the billets are heated by a producer gas fired continuous heating furnace. The delivery speed of the mill is 3,100 ft. per minute. The rods from this mill are coiled as done in No. 1 rod mill and loaded on buggies for shipment to the cleaning house.

Cleaning Houses

Each rod mill has its cleaning department or pickle house where the rods after cooling are dipped in an 8 per cent sulphuric acid bath and the scale removed. This is accomplished by threading the coils with a stem made of anti-acid material, the stem being lifted by hydraulic cranes and placed in the pickle vat. From the acid the rods are put in a rinse bath of water and then immersed in a lime bath. The lime coat is for lubricating purposes as the rods are drawn through dies in the wire mills. After receiving the lime coat the rods are again loaded on trucks and placed in a baker to dry. These bakers are ovens heated to about 350 deg. F. and are designed with partitions and tracks. The trucks go through in line and are baked from three to four hours. The discharge end of the ovens is located in the wire mill and the trucks are then distributed to the various benches of the wire department.

Wire Mills

The wire mills have 488 blocks which cold draw the wire to any desired gauge. The rods are placed on reels which revolve and the front end is threaded through the die and attached to the wire block. To accomplish this threading it is necessary to point the end of the wire to a diameter smaller than the die. The threaded end of the rod is grabbed by tongs and is mechanically pulled to sufficient length to allow the wire to be fastened to the wire block. The block is then dropped in gear and draws the rod through the die. This operation is called wire drawing and if one pass is sufficient to bring the wire to finished gauge it is termed one draft wire. If two passes are necessary, two draft wire and so on. The maximum reduction in good wire drawing practice is between 1/32 and 3/64 in. per draft.

Where wire has to have more than three drafts it is necessary to anneal the wire as the cold drawing operation causes the wire to become brittle and it must be annealed before further drawing can be done. Most wires are drawn through a lubricant before entering the dies. Lime and grease are principally used in drawing wire. Small electric cranes with hoists serve all the wire benches by lifting the rods from the trucks and stripping the wire from the blocks. The mills are well ventilated which is most important as a fine lime dust will permeate the air unless proper precautions are made.

The galvanizing department consists of seven pans which cover the bright wire with a zinc coating. These pans have a capacity of 350 tons of galvanized wire per day. A description of the equipment and operation might be of interest. The bright wire is placed on reels which revolve. The head end of the wire is threaded through grooves and pulleys to a molten lead bath where the wire is drawn through the lead. This operation anneals the wire so that it will be easy to fabricate into fence or other material. Out of the lead bath it is guided by grooves over a cooling rack and then passed through a solution of hydrochloric acid to clean the wire. From the acid bath it is rinsed through a water bath and is dried by hot plates before entering the zinc pan. The zinc pan is about 22 ft. long and 18 in. deep. The wire is drawn through the molten zinc, the zinc adhering to the wire. To insure a smooth coating the wire is then sent through wipes which smooth the surface of the wire and wipe off excess zinc. From these wipes the wire goes to a cooling rack and then down to the blocks which are driven by motors and is wound on these blocks in coils. There are three types of wipes, charcoal wipes for special galvanizing, lever wipes and screw wipes, all designed to give the customer what he desires.

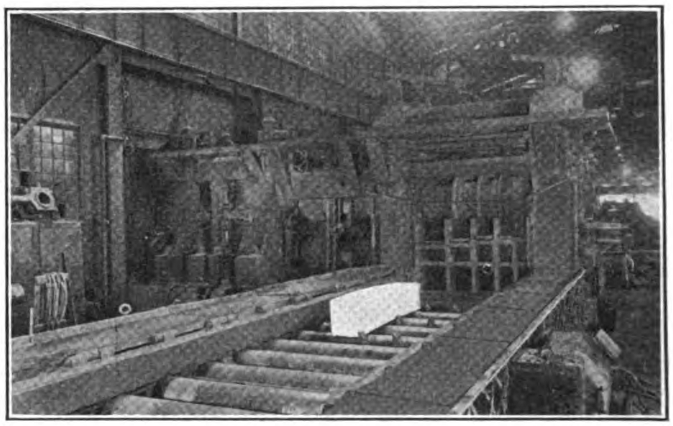


FIG. 5—Blooming mill.

Fence Department

Two general types of fence are manufactured by the Pittsburgh Steel Company, electrically welded fence and what is termed wrapped fence. Welded

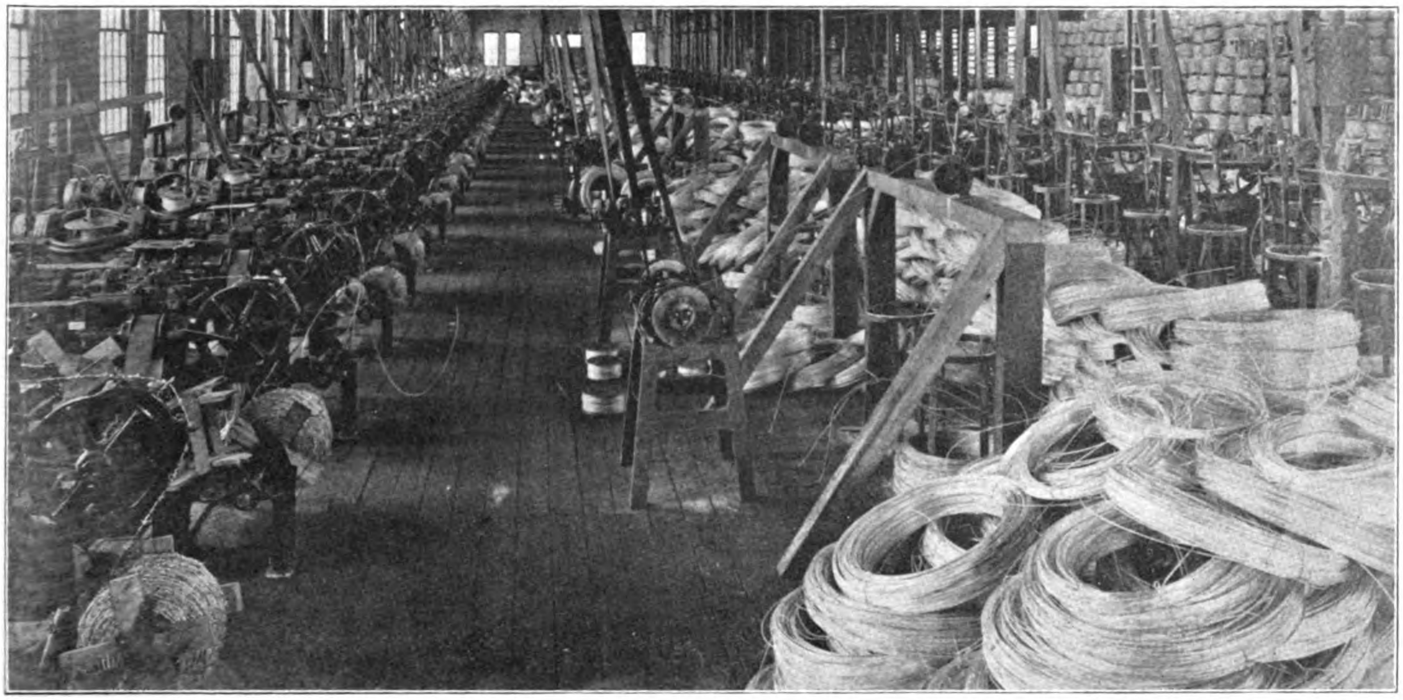


FIG. 6—Wire mills.

fence is manufactured through the application of electric spot welding. In applying this process an electric arc is formed between two pieces of wire, creating sufficient heat to weld the pieces together. This weld insures a strong positive joint and gives it additional strength at the weld, as the thickness of the wire at the weld is doubled.

The looms on which this type fence is made is so threaded with wire that the fence is formed and when run through the machine the cross wires are welded. The wrapped fence is made on somewhat similar looms, except the joints are wrapped instead of being welded. Both the electric welded and wrapped fence is made up in many styles, having various heights and spacings of wires. All the electric welded fence is known as Pittsburgh Perfect. The wrapped fence is known as Pittsburgh Columbia which also has many styles. The Pittsburgh Chicktite is one of the new styles of wrapped fence which is built, as the name implies, to fence in small chicks. The galvanizing department manufacturers all styles of galvanizing and fittings and posts for lawn and industrial fence.

Nail Mill

In connection with the wire plant the Pittsburgh Steel Company has erected one of the most complete nail plants in the country. In this there are 370 nail machines which, when operating at capacity, are able to produce 10,000 kegs of nails per day of all sizes and finishes. The machine used for the manufacture of nails performs a twofold operation simultaneously; the first operation cuts the wire while the second upsets, or heads, the nail. The stock—a coil of wire on a reel—enters at the rear of the machine and is fed through a die, having a vise-like grip.

After the wire has entered the nail machine it is cut by a series of blades so formed that the point of the nail is of the type desired. Concurrent with this operation, as the nail is held in a "vise-like" grip, the head is formed by an upsetting operation in which the head is pressed into shape by a die. This operation also centers the head on the shank. When the nail has been finished it falls from the die into a tote box at the base of the machine from which it is carried to the tumbling barrel and cleaned. It requires a half hour for the nails to be cleaned in the revolving barrels. In these barrels sawdust is placed for the purpose of absorbing the oil or other grease on the nails and also by abrasion to remove any foreign particles. The sawdust must be renewed at frequent intervals as that in the barrel is gradually forced out through the grooves and holes in the sides and bottom of the drum. After the nails have been thoroughly cleaned they are removed from the drum and placed on a table in which there are openings with a diameter smaller than that of the mouth of the keg. Under these openings the kegs are placed and the nails pushed into them through the table openings, after which the kegs are carried to a scale and weighed. Should it be desired to give the nails a cement coating they are placed in a barrel in which there is a solution containing the proper ingredients for cementing. Nails which are to be galvanized, or blued, are trucked into a room adjacent the nail department where there is equipment adequate for the work to be done. This department is equipped with means for packing and weighing similar to that in the nail department proper. The size of the nails manufactured is such that they may fill any requirements; thus there are nails 6 in. in length and No. 2 gauge, also 1 in. length and No. 15 gauge, besides which there are the following varieties: Brads, common nails, casing, flooring, smooth, boat, roofing, slating, shingle, clinch, hinge, box nails as well as spikes, dowels, special treated nails and lath nails. In order that the various brands may be readily distinguished the Pittsburgh Steel Company has adopted the practice of identifying each brand by a distinctive color; thus the galvanized nails are identified by a silver band painted on the head band of the keg, the sterilized nails by a blue band, and the cement coated nails by a gold band, while the common type of nails are recognized by the black band.

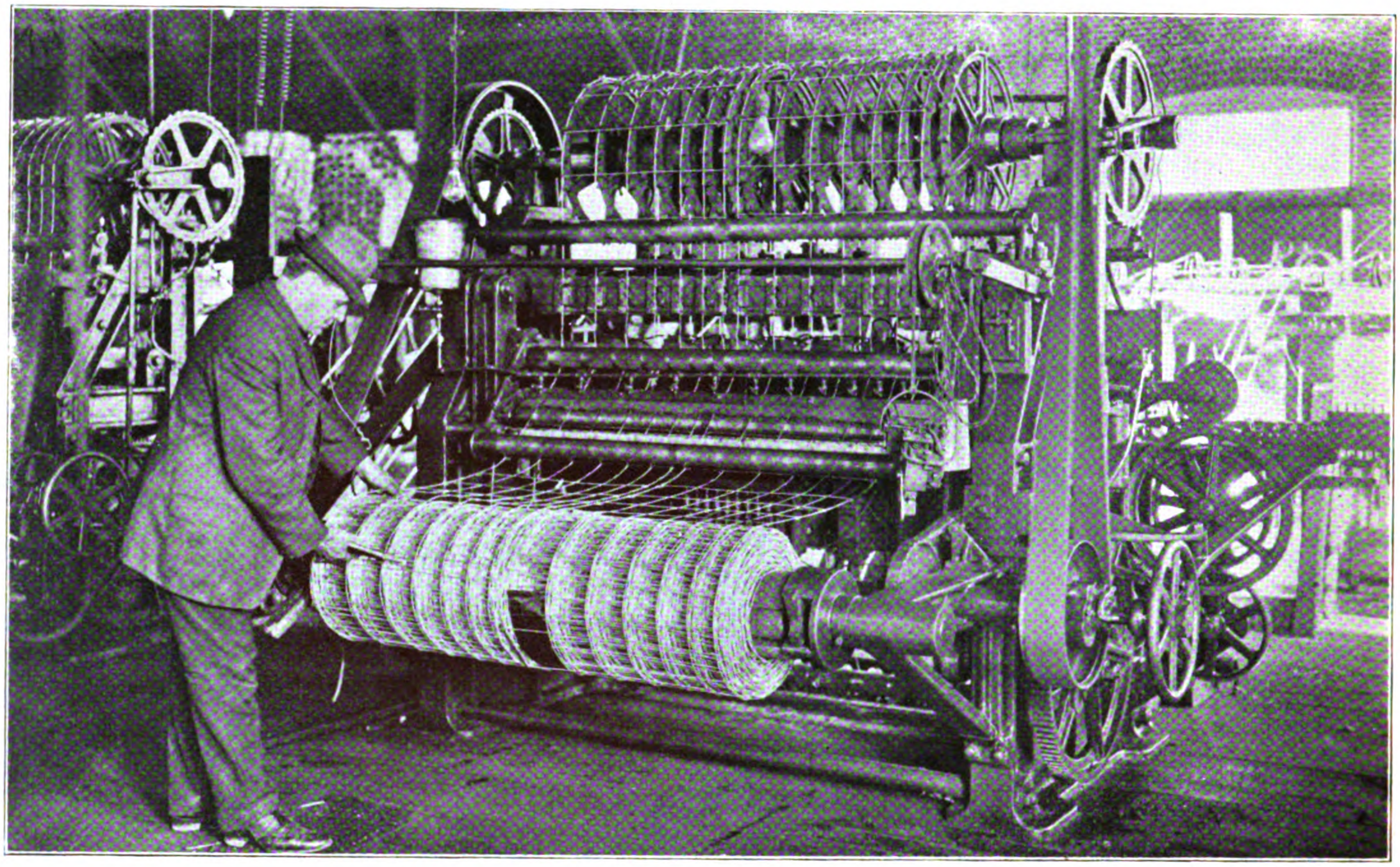


FIG. 7—Fence machine.

The location of the equipment in the several nail making shops conforms to the same symmetrical and efficient layout as in other departments. For instance the 370 nail machines are operated by a motor driven line shaft from which belts run to the nail machines. For the transportation of the material the shop has been constructed with one broad center aisle with narrower aisles on the sides. The tumbling barrels and keg manufacturing departments are located at the lower end of the shop which has been built for convenience on two levels. The kegs are built in the department on the upper level while on the lower level the tumbling barrels have been installed. As the kegs are finished they are sent down on chutes to the room containing the tumbling barrels where they are filled, weighed, headed and stamped with the appropriate band before being carried to the shipping room. The output of the nail shop when working double turn is about 10,000 kegs per day. Most of the equipment in the nail making department has been furnished by the National Machinery Company; Jos. T. Ryerson and E. W. Bliss Company have also supplied several machines. Close by the nail shop is a die room in which the dies for the various machines are formed and heat treated. This die room is well equipped with lathes and other machinery for die sinking and with several heat treating furnaces.

The barbed wire department is equipped with 53 machines for the manufacture of various styles of barbed wire. Two strands of wire are twisted by this machine and a cross wire is wrapped at equal intervals and cut with barbed ends protruding from the wire. Many styles of barbed wire are made in this department which gives a full line of styles for the trade. Straight and cut wire, staples, bale ties and many other specialties are produced which fills out a full line of wire products.

The Pittsburgh Steel Products Company

The growth of the Pittsburgh Steel Products Company has somewhat the same history as that of the Pittsburgh Steel Company.

It was organized in 1904 and its first plant was built at Monessen, Pa. It started on a very modest scale, having one unit, producing boiler tubes. After considerable sales resistance as to the quality of seamless tubing, the demand for seamless tubes outgrew the production of the initial unit and two additional units were installed. A specialty department was added where tubes were formed to meet the demands of the automotive industry. This field has developed to such an extent that this department has grown to one of the largest units of the company. During the war, to meet the demands of the government, the Allenport plant of this company was built which supplied a large proportion of boiler tubes for government work.

With the development of the rotary drilling in the oil fields the demand for stronger drill pipe and casings grew and inquiries for larger diameter pipe developed. In 1924 the directors of this company after very careful investigation, both at home and abroad, entered into a contract with the Demag Company of Duisberg, Germany for the building and erection of a pilger mill for the making of tubes from 6 in. to 13⅜ in. O.D. September 1926 this mill made its first shipment of pipe to the oil country, being the first mill in the country to make a seamless tube over 12 in. From 3,000 to 24,000 tons per month gives the actual growth of this company since its inception.

The Pittsburgh Steel Company supply their requirements for pilger ingots and tube rods. Both companies being located on the river, the ingots and billets are shipped by barge to Allenport where they are unloaded in storage yards and ready for use.

The Pilger Mill

This mill which is a German invention, received the name pilger from the fact that in passing through the mill the ingot has an alternate forward and backward movement similar to that of the medieval pilgrims, who, in making a journey would step two steps forward and then one backward. The process as will be described later combines both rolling and forging and insures a well worked material. The mill was built by "Demag" of Duisberg, Germany and was installed and placed in operation by this company. The plant consists of a Mannesmann piercing mill followed by two pilger mills, a sizing mill, and a straightening mill. After the tubes have been formed they are transferred to machines to be finished. The ingots from which the tubes are made as previously mentioned, are cast in the open hearth department and receive no further treatment until they reach the pilger mills.

From the storage yard the ingots are lifted to the charging platform back of the heating furnaces from which point they pass into and through the furnaces. These furnaces were built by the Pittsburgh Steel Products Company, after the pattern of the standard type of continuous furnace; hence the floor has a pitch from the charging end to the point of discharge. Each furnace is fired with natural gas in burners placed directly over the discharge door at the end of the furnace. The furnaces have a length of 50 ft. 6 in. and a width of 15 ft. and are covered by a suspended arched type roof furnished by the American Arch Company. As the furnace is of the end discharge type the ingots fall directly on to a roll-table which conveys them to a machine which lifts them on to the feeding rolls for the Mannesmann mill. In this mill the ingot is pierced according to the standard practice in mills of this type, viz., by forcing a mandrel through the billet as it is rapidly revolved by rolls placed in such a manner that their center lines are at an angle. The tendency of the rolls so placed is to create an area of less resistance through the middle of the ingot and thus enable the mandrel to pass through with less effort. After the piercing operation the hollow, thick walled tube is carried by an electrically operated car to one of the pilger mills. Here the partially formed tube is dropped on to the roll table which conveys it to the mill proper. The rolls in the pilger mill differ from those in the common type of mill in that at only one point does the diameter of the opening between the bottom and top roll correspond to the diameter of the finished tube. The form of the roll is shown in Fig. 11. In operation the tube is placed on a mandrel and forced into the rolls. As these revolve the tube is forged down to the desired thickness and diameter, hence the stock moves forward receiving a blow at each revolution of the rolls, in consequence of which the length of the tube is increased about 5 in. per revolution. In order that the blows from the two mills may not occur simultaneously they are so synchronized that they alternate.

After the tube has passed through the pilger mill it is moved by a roll table to a hot cut saw where

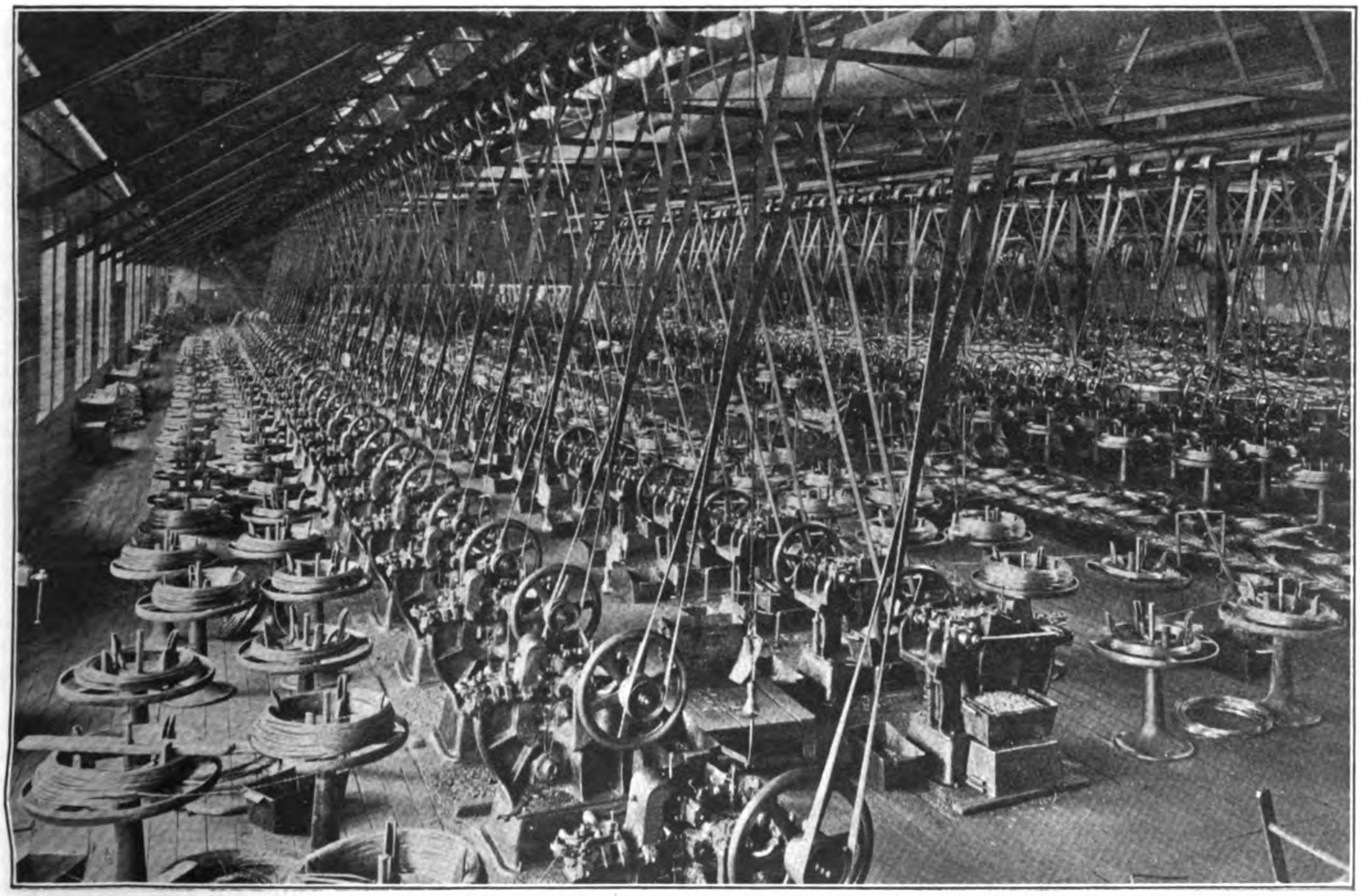


FIG. 8—Nail machines.

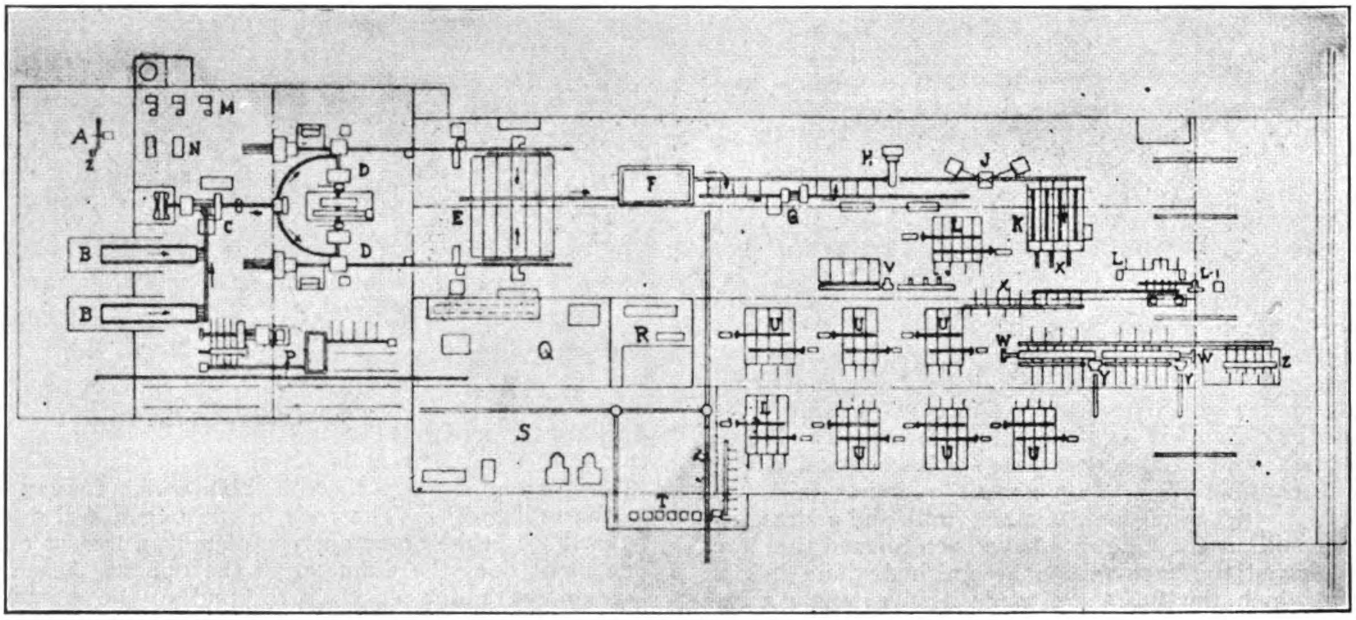


FIG. 9—Lay-out of the Pilger Mill Plant, Allenport.

Key—(A) ingot breaker; (B) ingot seating furnace; (C) piercing mill; (D) pilger mill; (E) transfer table; (F) reheating furnace; (G) reeling machine; (H) sizing machine; (J) cross rolling machine; (K) cooling table; (L) cut-off machines; (L-I) flattening press; (M) hydraulic pumps; (N) air compressors; (P) mandrel reclaiming machines; (Q) electric sub-station; (R) roll shop and tool room; (S) coupler and thread protector department; (T) galvanizing department; (U) threading machine; (V) straightening press; (W) hydraulic testing machine; (X) inspection tables; (Y) screwing-on machines; (Z) scales.

both ends are trimmed. The tube which now approximates 50 ft. in length is placed upon a mechanism, weighed, and then taken to the reheating furnace across which it rolls until thoroughly heated when it is placed upon water cooled rollers and discharged to the sizing mill. From the sizing mill the tubes are conveyed to straightening cross rolls and then to the cooling table where after being sufficiently cooled they are subjected to a thorough inspection. From the inspection tables the tubes are taken to the final straightening press where any irregularities are removed. The next step is to clean, ream and chamfer the rough ends. A final inspection is then given each tube. As the tube is now true to form these ends are threaded and a coupling placed on the one end while on the thread at the other end a protector is fastened. The threads of the above tubes and couplings are inspected during this operation. The piece is then subjected to a hydrostatic test and given a coat of oil. When this coating has dried sufficiently the tube is marked, weighed and measured and is then ready to be placed in stock or loaded into freight cars for shipment. There are many machines performing minor functions distributed throughout the shop which are employed in some manner with the finishing of the tube; thus there is a small shop in which the Mannesmann mill mandrels are upset and redressed after they have become worn in the service, also automatic threading machines of the vertical type, capable of turning out multiple quantities of finished couplings and thread protectors. In the manufacture of tubes by the pilger process the layout of the different pieces of equipment is such that the semi-finished and finished material progresses as from the preliminary heating furnaces to the loading platform. Furthermore as the piece passes to each successive step, means are provided by which it can be economically handled and for this purpose the building, housing the various furnaces and machines, has been built with ample space for the movement of all material.

The finished tubes are made in lengths up to 50 ft. and in diameter up to 13⅜ in., while the average capacity of the plant is about 300 tons per day.

Small Tube Mills

In this plant there is machinery for the production of tubes up to 7 in. in diameter. These tubes are produced on four tube mills provided with the all requisite auxiliary equipment such as reeling mills, sizing mills, cold drawing benches and machinery for special work such as bending, upsetting and forming the tubes into irregular shapes.

On unloading the blooms or billets from the freight cars they are placed in the storage yard, or on the charging platform preparatory to being fed into the furnaces. The furnaces are of the continuous type with an end charge and side discharge and as in the standard type of furnace the billets pass over a sloping hearth on water cooled skid pipes. On reaching the point of discharge the billet is withdrawn from the furnace and placed on the roller-table by hand. The billet is then moved to the Mannesmann mill and pierced in the manner peculiar to this mill. Two men are required to operate the mill, one of whom withdraws the mandrel as the process is completed, while the other operates the rolls and conveying machinery. After the piercing operation is completed the semi-finished tube passes over tables to rolling mills where it is forced over a mandrel and through a set of rolls. This is performed by inserting a rolling plug in the head of the piece as it reaches the first set of rolls and it is then pulled over the plug by three or four sets of rolls until the desired inside and outside diameters are obtained. After leaving this series of rolls the tube has a slightly oval shape. The next treatment to which it is subjected is to pass through the reeling rolls which consist of a set of rolls with their axes slightly inclined. While passing through these rolls a revolving mandrel is forced through the tube in such a manner that the tube is burnished on both the inside and outside surfaces while at the same time the piece is made perfectly round. It is then ready to be reheated.

The furnace in which the tube is reheated is fired by natural gas in burners so spaced that the temperature throughout the furnace heating chamber is practically uniform. The tube is discharged from the furnace on water cooled rolls and then passes to one of two sizing mills. One of these mills sizes tubes over 3 in. diameter, while the other takes care of those of a smaller diameter. This operation affects only the outside of the tube. The largest tubes are passed through four sets of rolls, two of which are vertical and two horizontal, and so finished as to form the tube accurately to the diameter desired. As the material before reaching the rolls is slightly oversized it is reduced to an exact diameter and slightly elongated. Should the tube not be true to shape on entering the rolls it will emerge accurate in diameter throughout the whole length.

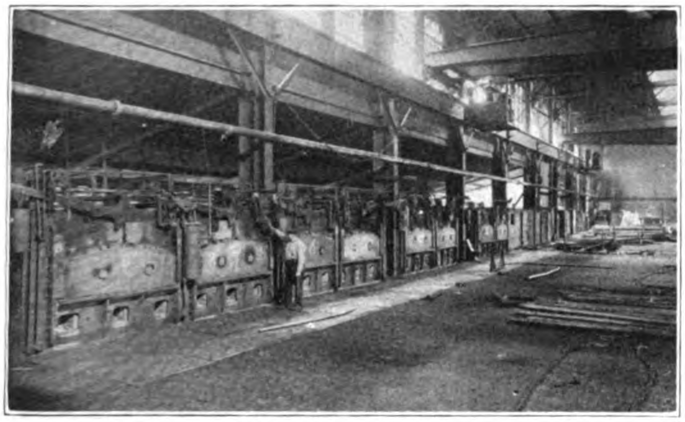


FIG. 10—Heating furnaces.

The straightening rolls are located at the end of the transfer table over which the tubes pass on leaving the reheating furnace. Tubes of the smaller sizes must be given a greater number of passes due to the fact that the rolling operation not only sizes the tube, but also reduces it. The pass in each succeeding set of rolls is smaller than that in the preceeding set and as there are 18 sets of these rolls the stock is slightly reduced in each pass until on leaving the last set it is true to size. The first passes are slightly oval, but as the final passes are reached the tube is finally worked into a perfect round. Tubes have a diameter as small as 1½ in. when finished in these rolls. From these rolls the tubes pass through the straightening machine, after having reached the preliminary inspection on the cooling beds. On leaving this machine they are entirely free from kinks and buckles and will pass the most rigid test for commercial straightness. Most of the stock is sent from the straightening machine direct to the cold drawing department, but that part not to be cold drawn is cut to length, threaded and given a final inspection for size, gauge and surface defects. The tubes are then marked, bundled and ready for shipment.

To meet the more exacting demands of the consumer of tubular goods means were devised by which tubes conforming to accurate dimensions and with similar wall thickness could be manufactured. To answer this purpose the tubes are cold drawn, in which process the pieces are not only elongated, but also are given a smooth finish and hardened. This procedure not only hardens the metal, but also induces brittleness to such an extent that it is necessary to subject the tubes to an annealing heat. Before any further steps are taken it is necessary to prepare the tube from the hot mill for the cold drawing process. This consists of swaging or pointing the tube so that it may go through the die, and then thoroughly cleaning it so that all scale is removed. The first step is accomplished by heating the end of the tube to such a temperature that it can be flattened under a forge hammer, the object of which is to enable it to be securely held when it is being drawn through the dies.

To clean the tubes they are dipped in a vat containing sulphuric acid of sufficient strength to remove all the scale without attacking the metal; the sulphuric acid solution is then removed by immersing the tubes in water. On being removed from the cleaning liquid each piece is coated with a lubricant consisting of oil and flour, or wax, and they are then placed where the lubricant may properly dry before being laid on the drawing tables. Three methods of drawing are used: the first of which consists in inserting a rod with a tapered end or mandrel in the tube and drawing both the mandrel and the tube through a die. The power to pull the tube is furnished by a gripping vise fastened to an endless chain. This machine in pulling the tube and rod through the die insures accurate inside and outside dimensions. From this operation the tube passes through another machine where the tube is tapped with a hammer and the mandrel withdrawn. The complete process is repeated until the proper size of tube is secured. In carrying out the second method a rod with a mandrel on its end is placed in the tube at the point where the tube moves through the die. The space between the mandrel and the die forms a ring-like opening through which the tube is pulled over the mandrel and through the die, thus reducing the tube to the desired size.

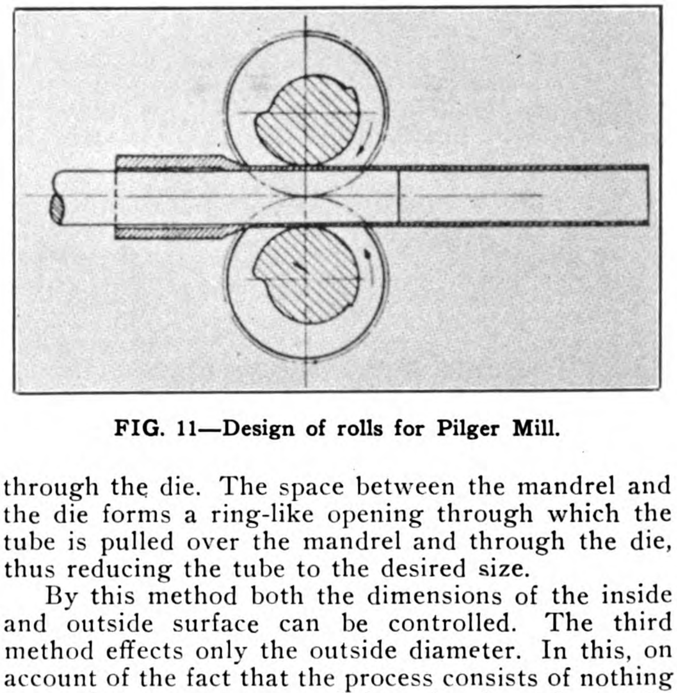


FIG. 11—Design of rolls for Pilger Mill.

By this method both the dimensions of the inside and outside surface can be controlled. The third method effects only the outside diameter. In this, on account of the fact that the process consists of nothing more than a movement of the tube through the die without the use of a mandrel on the inside, the method is employed only on tubes having a very thick wall.

It is a well known fact that the working of metal—especially cold drawing—produces brittleness to an

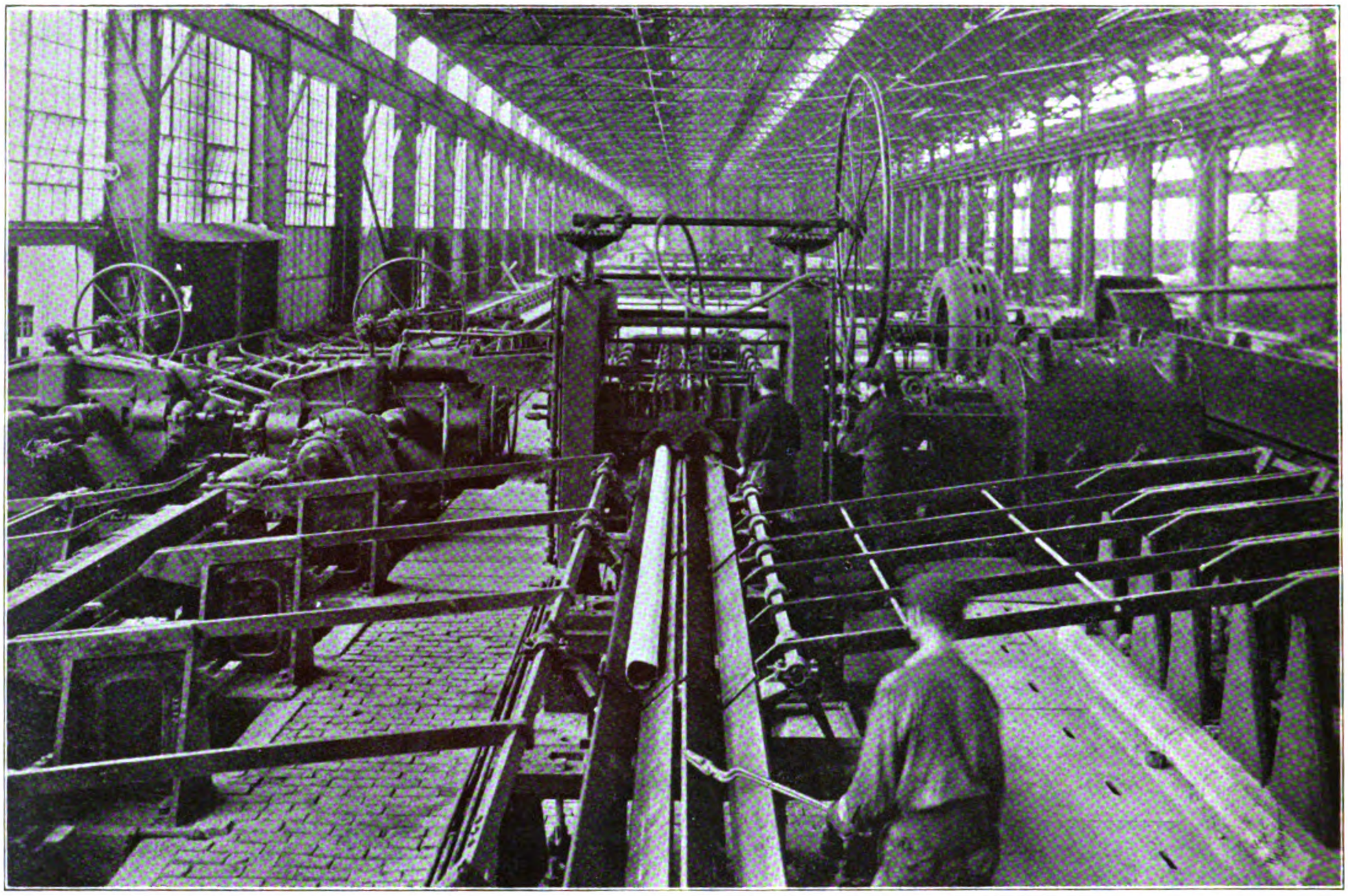


FIG. 12—Rolling tubes.

extent depending upon the amount of work performed. To restore the toughness of the metal it is necessary that it be annealed after being worked, consequently after the tube has been passed through the die, it is placed in the furnaces and annealed and then pickled after which it is in condition for another drawing operation. An annealing is also given the tube after the final drawing and before it is passed on to be cut to length, tested and threaded.

As there are a great many uses to which the tube may be applied, it is necessary in frequent cases that it be bent to conform to a template or be upset, or otherwise altered in form. The automobile industry especially demands material of this description and furthermore is insistent on the material meeting exacting specifications. The boiler manufacturers also contract for the large output of bent tubes.

In this department, as in those previously described, the shop layout follows the straight line system as regards the flow of material. Here for instance the steel in the form of billets passes into and through the furnaces and from these direct to the piercing mill, the rolling mill, the sizing or reeling mill and then on in a straight line to the finishing machines. All movements are performed by some form of mechanical conveyance or by overhead cranes. On account of the unusual amount of material to be moved in the drawing department, it is somewhat difficult to establish a definite line of movement; hence the general plan is to transport the tubes from and to the various pieces of equipment by means of trucks. These trucks are loaded and unloaded by overhead traveling cranes. The use of trucks is also requisite due to the fact that the pickling department is located in a separate building which requires that the trucks pass through the space separating the two buildings.

To carry out all the various operations required for the making of small tubes four parallel buildings have been constructed in such a manner that they discharge all material to the fifth building. This building, while really a part of the four just mentioned, is located at the end and at right angles to the others so that the finished material can be passed directly into it. In this latter building the material is inspected and loaded for shipment. This inspection includes a thorough examination for surface defects and the proper identifications as regards the weight and length of the pieces.

General Remarks

In the foregoing description of the plant of the Pittsburgh Steel Company the aim has been to describe the principal departments of the company and to a lesser degree the methods of operation. In such a short description it is impossible to cover many of the features which are of much significance, but it is hoped that the ground has been covered sufficiently to give an adequate conception of the production of the various commodities in this plant where the quality of the products is paramount. It is of course apparent that for the maintenance of the various pieces of equipment, departments such as machine shops, repair shops, and power plants, etc., must be maintained. These departments are all adequate for the work to be performed.

River Transportation

An important feature of any steel plant is its ability to release and distribute its finished goods. Usually plants are constructed with a certain definite market in view and an inexpensive means to reach it is a primary consideration in its location. Originally the river transportation facilities constructed here were used only for interplant activities, but it was soon realized the market covered by the Mississippi and Ohio River systems presented great opportunities for the release of the finished material. Hence the docks and loading equipment were fitted up to handle large tonnages of completed products and boats and barges were acquired to fit into a general water transportation system. Through the Mississippi River system of which the Monongahela is a part, material is able to reach practically all the large distribution points of the southeastern, southwestern, and middle western markets. The Mississippi is navigable from Cairo, Ill., south the year round and with the completion of locks between Cairo and Louisville, Ky. the usual delays incidental to low waters will be eliminated.

The company has large warehouses at St. Louis, Mo., Memphis, Tenn. and Houston, Texas, each of which is a natural outlet to a particular market. These warehouses are kept well stocked at all times and thus assures prompt delivery from these points as ordered.

A means of reaching a northern outlet for finished steel products was established when the Federal barge lines opened a service between St. Louis, St. Paul and Minneapolis and it is expected that a large tonnage of steel will move through that means in a very little while. Pittsburgh Steel Company has been making river shipments for many years and during 1925 and 1926 approximately 40,000 tons per year were distributed through this means. In future years a much heavier shipment of tonnage is expected to be made, by water, to the various points of distribution.

Power Plants of Pittsburgh Steel Company

(Continued from page 76)

ally operated three-pole oil circuit breakers before reaching the 22,000 volt bus bars. These oil breakers are provided with protective relays to take care of grounds or short circuits on the incoming lines and on bus bars and overloads in the mill.

The Mill Substation is fed by duplicate 3-phase lines from the special substation. These lines enter the building through three conductors lead covered cables in conduit.

There is a volt meter on the main bus and a complete set of instruments on each mill drive so that demand and energy consumed by each mill can be determined. The connections are then made to the four primary breakers of the main mill motors through disconnecting switches.

The main mill motors can be started, stopped and reversed by push buttons located on each hoop mill. The substation operator can stop the main motors but cannot start them.

The secondary control of these motors is of the electro-magnetic type and provides for four point acceleration for the roughing mill motors with fly-wheels and five point acceleration for the finishing mill motors not having fly-wheels. The roughing mill motors have permanent secondary resistance to give 10 per cent slip at full load so as to use the fly-wheel effect during peak loads of short duration.

Alicia No. 1 and No. 2

These power plants are at the coal and coke plants and marine ways of the company.

The Alicia No. 1 Steam Plant contains four boilers.

The Alicia No. 2 Steam Plant is for the operation of No. 2 coal mine. It contains six boilers.

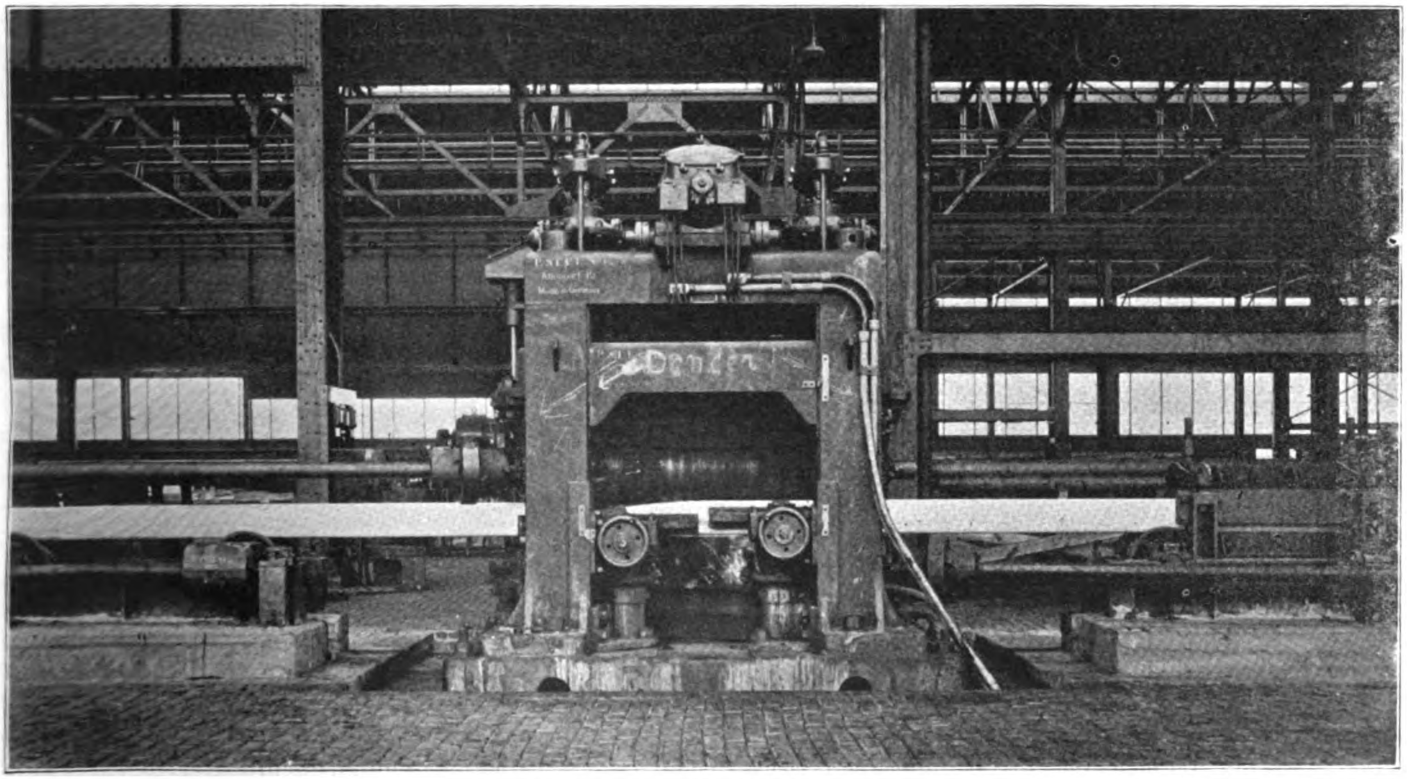


FIG. 13—Tube in the cross rolls.

Power Plants of Pittsburgh Steel Company

A Comprehensive Outline of the Power Equipment in the Various Works with Details as to Power Units, General Plants with Details as to Power Units, General

By W. EDGAR REED*

THE works of the Pittsburgh Steel Company are the result of gradual development and as extensions were made the power plants were enlarged or new ones built to suit the new power requirements and the locations of such extensions. During this development several smaller works with their existing power plants were acquired.

The present large works are, therefore, spread over considerable space and are in different localities and the power is consequently made in several different plants of various capacities and ages.

There now exist power plants at the following locations: Monessen, Allenport, Glassport, Alicia No. 1, Alicia No. 2.

The main equipment in some of the recently built plants is electrically driven and in some of the earlier installations it is steam driven. The Allenport, Glassport and Alicia plants are principally electrically driven. The main mills of the Monessen Works are steam engine driven with the exception of the Seamless Tube and Wire Mill Departments and miscellaneous and auxiliary equipment that are electrically driven.

Monessen Works

There are really four power subdivisions in the Monessen Works, viz.: the Finishing, Blooming Mill, Blast Furnace and Seamless Tube Departments. Each of these departments has a particular power supply although they are interconnected and form part of the general power system.

The Finishing Department includes the Rod, Wire, Nail, Fence and Fabric sections and nearly all the main drives are by steam engine.

The Blooming Mill Department includes the Blooming, Bar, Billet and Open Hearth sections, all the large main drives being also by steam engines.

Two boiler plants interconnected produce the steam for the above departments, one boiler plant being located in each of the departments, and being connected by a large steam line, which is supported on a bridge crossing the P. & L. E. R. R.

The steam is generated at 150 lbs. pressure using coal as fuel in both plants. The Finishing Department boiler plant (No. 3) contains 9,000 rated boiler hp. and the Blooming Mill Department boiler plant (No. 2) contains 7,500 boiler hp., making a total of 16,500 hp. The boilers are 500 hp. Sterling Type and the stokers are of the chain grate type. These two boiler plants furnish steam for the following large equipment, as well as for various small equipment, gas producers, pumps, process work, etc.:

46-in., 3-high, Blooming Mill Engine, 2,500 hp., 62 rpm., Horizontal, Vertical Compound Southwark Corliss Condensing Type.

Billet Mill Engine, 2,100 hp., 64 rpm., Horizontal, Vertical, Compound Southwark Corliss Condensing Type.

Bar Mill Engine, 1,900 hp., 78 rpm., Horizontal, Vertical Compound Southwark Corliss Condensing Type.

Garrett—Rod Mill No. 1, Engine No. 1, 2,500 hp., 60 rpm., Horizontal, Vertical Compound Allis-Chalmers Corliss Exhausting to low pressure turbine.

Garrett—Rod Mill No. 1, Engine No. 2, 2,200 hp., 75 rpm., Vertical Cross Compound Allis-Chalmers Corliss Condensing Type.

Garrett—Rod Mill No. 1, Engine No. 3, 1,200 hp., 110 rpm., Horizontal Cross Compound Buckeye Piston Type. Exhausting to a feed water heater.

Garrett—Rod Mill No. 1, Engine No. 4, 1,200 hp., 80 rpm., Horizontal Cross Compound St. Louis Corliss Condensing Type.

Morgan—Rod Mill No. 2 Engine, 2,000 hp., 100 rpm., Horizontal Cross Compound Allis-Chalmers Corliss Condensing Type.

Wire Mill No. 1 Engine, 1,300 hp., 80 rpm., Horizontal Cross Compound St. Louis Corliss Condensing Type.

800-kw. Engine Generator Set.
400-kw. Engine Generator Set.
1,000-kw. Turbo Alternator.
600-kw. Turbo Alternator.
Four 500-kw. Engine Generator Sets.

The Blast Furnace Department, being some distance away from the other departments, also has its boiler plant. This boiler plant is fired by blast furnace gas with provisions for auxiliary side firing of coal when necessary. It includes 17-500-hp. Sterling boilers and special blast furnace gas burners. This gas is not washed and its sensible heat is available for steam production.

The gas burners are a special suction type built after tests were made of available burners at the time they were installed. They give good mixtures and show high efficiency for this type of burner. The steam is generated at 160 lbs. pressure and is used for operating four blowing engines, 35 to 52 rpm., Vertical, Steeple, Corliss, Southwark type, which exhaust to turbines and feed water heaters; three 3,000 kw. turbo-alterantors, mixed pressure, condensing, Southwark and miscellaneous equipment. About 25 per cent of the blast furnace gas produced by two, 600-ton blast furnaces is washed and then is used in the stoves and the rest is used in the boiler plant, producing, after driving the blowing engines and other equipment, about 7,000 kw. of electrical power in the turbo-alternators. Since the blast furnace gas is a waste fuel and boiler plant labor when burning gas is low, electric current is generated at a very low cost. This electrical energy is used for operating cranes, ore hoists, coke conveyors and other miscellaneous equipment and for driving motors in the wire mill and the entire seamless tube department in Monessen.

---

*Consulting engineer.

The Southwark turbines are of the mixed pressure type using live steam when there is not sufficient exhaust steam coming from the blowing engines. The alternators are of the Crocker-Wheeler make and generate current at 2,200 volts, 3 phase and 25 cycles.

Two, 750 kw. motor generator sets furnish all the d.c. required at the blast furnace department.

The Seamless Tube Department uses most of this excess electric power. Part of the mill drives are by a.c. motors and part by d.c. motors. The d.c. power is transformed from a.c. in a substation (No. 3) containing three 750 kw. motor generator sets.

The larger motors are used for the piercing, rolling, expanding, sizing mills and air compressors.

Some of this excess power is, also, used in the finishing and blooming mill departments for the operation of No. 1 wire mill, cranes, and auxiliary equipment. There are four 750-kw. motor-generator sets for transforming this a.c. to d.c. located in substations No. 1 and No. 2 in the finishing and blooming mill departments.

The No. 2 substation and the blast furnace substation receive all their electric power from the blast furnace turbo-alternators while No. 1 and No. 2 substations receive electric power not only from the blast furnace turbo-alternators, but also from engine generator sets located in these latter two substations. They, therefore, have two sources of supply available. And further, the secondary or d.c. feeders are interconnected so that when necessary any substation can receive help from any other station.

For the drive of equipment there is now installed about 32,000 hp. of engines, 6,600 hp. of motors, 25,000 hp. of boiler capacity.

The water supply for the Monessen Works is pumped from the Monongahela River. The pump house is located on the bank of the Monongahela River. The intakes are protected by piling and screens to prevent the entrance of ice and other obstructions. The pump house is steam driven and receives this steam from boiler plant No. 2. It contains four 15,000,000-gal. per day Allis-Chalmers pumps and one, 30,000,000-gal. per day Worthington centrifugal pump driven through gears by a 1,400-hp. Kerr steam turbine.

Booster pumps are provided for the blast furnace cooling system and are used to increase the normal pressure when necessary.

The original installation contained five pumps of 15,000,000 gals. per day each. When more water was required it was found that a 30,000,000-gal. centrifugal turbine driven pump could replace an existing engine driven piston pump without enlarging the pump house. The piston pumps are efficient if the water is clean, but when leaves or other material are in the water there is considerable slippage in the numerous small valves of each pump suction.

The water mains are connected to a surge tank to take up variations in supply pressure.

Allenport Works

The Allenport power plant furnishes steam for process work, heating and the generation of electric power for the operation of the seamless tube mills.

Steam—The Steam is generated at 175 lbs. pressure and 125 deg. superheat in six 500-hp. Sterling boilers, coal fired. The stokers are of the Combustion Engineering Company's underfeed forced draft type. The boilers are provided with steam purifiers. The make-up water is treated with Cochrane purifier and feed water heater.

The Stokers are Frederick, 5-retort underfeed forced draft type. They are guaranteed to carry 250 per cent rating continuously and 300 per cent for four hours and to have a combined boiler and furnace efficiency of 77 per cent at 200 per cent load and 75½ per cent at 225 per cent load. The stokers are built suitable for the use with preheated air if it is desired in the future to use.

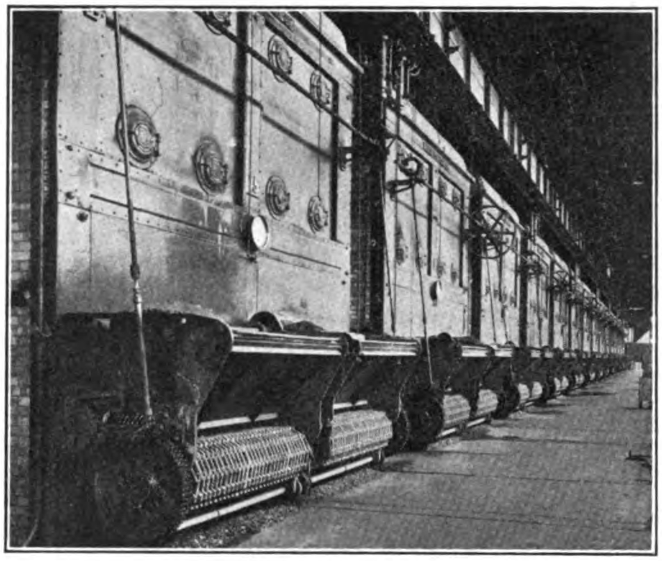


FIG. 1—Boilers.

The Hagan system of combustion control is installed and each boiler is equipped with indicating and integrating steam flow meters and a complete system of gauges.

The Coal is delivered in bottom dump railroad cars or by barge. It is dumped into a track hopper and then conveyed by a bucket elevator, through a magnetic separator to a screen at the top of the building. The coarse coal is fed to a bin and taken to the gas producers while the finer coal is crushed and fed to a belt conveyor that discharges it into a coal bunker extending along the front of the boilers. From this bunker the coal runs by gravity down chutes to the various stoker hoppers. The bunker has a capacity of three tons per foot of length.

The Ashes are discharged from the stokers into a brick lined cast iron hopper provided with sliding gates from which they are dumped into an ash car. This car is electrically operated and self-dumping and it carries the ashes to a pit at the end of the boiler house.

The power generating plant contains two 7,500 kw., 1800 rpm., G. E. turbo-alternators and one, Allis-Chalmers 2,500-kw. turbo-alternator. All current is generated at 6,600 volts, 3 phase, 60 cycles.

The 7,500-kw. turbo-alternators are guaranteed to produce a kwh. with a steam consumption of 13.5 lbs. at full load.

Steam flow meters are installed in the power plant and other departments for charging the proper amounts thereto. This reading in the power plant together with the kwh. meters on the turbines gives a direct check upon the operation of the units.

A steam connection is made to the turbo-alternator that can be used to extinguish any fires that may accidentally start in the alternator.

Condensers—The condensers are Wheeler Type Condensers. Condensing water is taken from the river through grate bars into a well. It then passes through revolving screens to the condenser and is then again returned to the river.

The condensers are equipped with steam jet air pumps, but there is also one reciprocating air pump that was originally installed with the 2,500-kw. turbine. The air pump can be used in starting up or operating any of the condensers.

The cooling air for alternators is washed by a Spray Engineering Company washer and then after passing through the machines exhausted to the outside.

The switchboard consists of unit cells, concrete construction and black marine finish panels with a complete line of equipment and instruments.

This electric power is used for driving the hot mills, cold draw, finishing mills, substations and pilger mill departments. The substation contains air compressors and synchronous M. G. sets for the transformation of a.c. to d.c., for the operation of variable speed drives, cranes and auxiliary equipment. The larger motors are used in the pilger mill and hot mill departments. These large hot mill motors are for the piercing, rolling and expanding mills. The cold draw department uses motors up to 150 hp.

The following table gives the ratings of the larger motors:

	Piercing Hp.	Rolling Hp.	Extractors Hp.	Cold Draw Hp.
No. 1	450	600	100	150
No. 2	450	300	...	150
			Expanding	Sizing
No. 3	800	600	300	150
			300	

All the large motors are slip ring induction type motors with cast grid starting resistances. The motors that have high peak loads of short duration are also provided with automatic slip control to give 10 per cent above normal.

The principal power equipment of the pilger mill consists of a 2,250 hp. piercing mill motor, a 2,000 hp. pilger mill d.c. motor and a motor generator set to transform a.c. to d.c. for the operation of the pilger mill motor, also polishing and sizing mill motors, etc.

All these motors were purchased with the mill and are of typical European construction with liquid resistence starters.

The Piercing Mill Motor is rated at 2,250 hp., continuous rating at a constant speed of 147 rpm., 6,600 volts, 3 phase, 60 cycles. This motor is direct connected to the piercing mill. The starter is a water resistance starter. Since the bloom is in the piercing mill for considerable time no fly-wheel is used.

The Pilger Mill Motor is rated at 2,000 hp., 550 volt d.c. at any speed from 42 to 85 rpm. This motor carries a fly wheel to take the frequent peak loads of short duration. These peaks occur at each revolution of the pilger rolls and they are considerably higher than the minimum or the average load on the motor. The fly-wheel helps to smooth out these peak loads on the motor generator set and the generating station.

The motor generator set for use with the Pilger motor consists of a 2600 hp., 3 phase, 6600 volt slip ring motor and a 600 volt d.c. generator operating at 585 r.p.m. It is provided with a power factor compensator and a liquid resistance starter and skip regulator.

The Water Supply is pumped from the river by two electrically and one steam turbine driven centrifugal pumps. This equipment is located in a separate pump house.

Glassport Works

The Glassport Works strip mills were formerly driven by steam engines but were changed to electric drive in 1924 when some of the boilers and engines needed extensive repairs. Some steam is still used here for process work, heating and pumping. This steam is generated in some of the old boilers.

The electric current for driving this mill is purchased from the Duquesne Light Company. The current is delivered at 22,000 volts, 3 phase and 60 cycles to the special substation containing switching equipment and outdoor transformers where it is reduced to 2200 volts. There is also a mill substation, in view of the main mill drives, containing the primary and secondary control for the main motors, transformers and switching equipment for the low voltage 220 volt a.c. power circuits, a synchronous motor generator set and switches for the d.c. motor circuits.

The main mills are 8-in. and 10-in. hoop mills for rolling strip steel for hoops, bands, etc. They each have three, 3-high stands and one, 2-high stand in the roughing train and one, 2-high stand in the finishing train.

The four motors are direct connected to the mills. The roughing mills are provided with fly-wheels as the passes are short and reductions fairly heavy and the peak loads are thereby reduced somewhat.

The fly-wheel shafts are connected to the motors through flexible couplings and to the mill spindles through mill coupling boxes. The finishing mills do not have fly-wheels as there is but a single pass requiring too much time to be helped by fly-wheel effect. These motors are connected direct to the mill pinions through mill coupling boxes. A coupling shoulder against the bearing acts as a thrust collar in case a spindle is broken. The main motors are of the following sizes:

10-in. roughing mill, 750 hp., 249 r.p.m., 10,000 lb. fly-wheel, 10-ft. diameter.

10-in. finishing mill, 300 hp., 349 r.p.m., no fly-wheel.

8-in. roughing mill, 400 hp., 349 r.p.m., 5800 lb. fly-wheel, 8-ft. diameter.

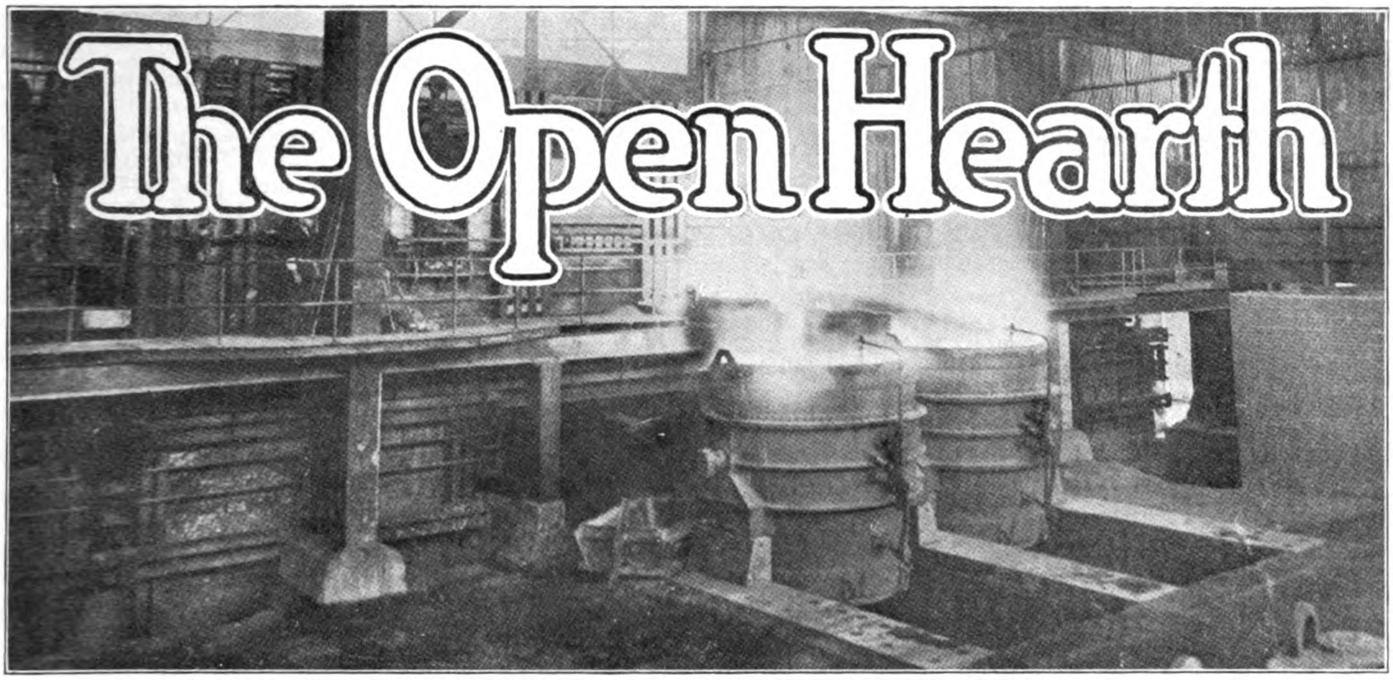
8-in. finishing mill, 200 hp., 436 r.p.m., no fly-wheel.

There are many smaller motors for shears, bundlers, coilers, roll and machine shops, blowers, conveyors and air compressors, etc.

The Special Substation for receving the 22,000 volts from the Duquesne Light Company is a brick and concrete building. The substation is fed by two 22,000 volt lines that form a section of a loop so that there are really two sources of electrical supply. These circuits are provided with choke coils, oxide film lightning arresters and disconnecting switches and manu-

(Continued on page 73)

The Open Hearth



He was with the American Bridge Company for a number of years, during which time he was assistant operating manager and manager of the forge department in the Chicago District. He practiced consulting engineering in Chicago and later became works manager of the Van Dorn Iron Works Company, Cleveland, Ohio.

* * *

C. H. Heist, for the past five years assistant manager of The Mayville Iron Company, Mayville, Wis., has been appointed manager, succeeding J. H. Means, resigned.

* * *

Van Cortright Mekeel, formerly connected with Taylor-Wharton Iron & Steel Company of High Bridge, N. J., in capacities of special research investigator, mechanical engineer and sales engineer, has resigned to accept a post as special representative of The Nugent Steel Castings Company, Chicago, Ill.

* * *

Harold A. Thomas, professor of hydraulics in the department of civil engineering at the Carnegie Institute of Technology, has been appointed hydraulic engineer for the City of Pittsburgh to make a study of flood heights as affected by various proposed changes on the water fronts, according to an announcement. His appointment was made by the Department of Public Works.

* * *

George F. Anglin, for the past four years Pittsburgh manager of The Torrington Manufacturing Company, Torrington, Conn., and the Blake & Johnson Company, Waterbury, Conn., before its merger with the former concern has joined the machinery and equipment sales department of Mackintosh-Hemphill Company, Pittsburgh, manufacturers of rolling mills and rolling mill equipment.

Mr. Anglin has had 20 years experience in various operating capacities with the Bethlehem Steel Company, Sharon Steel Hoop Company, Pittsburgh Crucible Steel Company and Pittsburgh Knife & Forge Company. He is a member of a family long associated with the iron and steel industry, being a son of E. J. Anglin, Sr., one of the old pioneer iron and steel men of the Pittsburgh district and a brother of E. J. Anglin, manager of steel plants, Weirton Steel Company, Weirton, W. Va.

* * *

Announcement was made on Tuesday, December 27 of the election of J. P. Morgan as chairman of the board of the United States Steel Corporation, thus filling the post made vacant by the death of Judge Gary on August 17, and of Myron C. Taylor as chairman of the finance committee. James A. Farrell continues as president of the corporation, and becomes its chief executive officer under the direction and supervision of the finance committee and the board of directors.

* * *

George P. Torrence, George L. Morehead, Frank B. Caldwell and W. C. Carter have been appointed vice presidents of the Link Belt Company. Mr. Torrence will have his headquarters at Indianapolis, in general charge of Indianapolis operations and sales of Indianapolis plant products. Mr. Morehead, in Philadelphia, will be in charge of Eastern operations and sales. Mr. Caldwell will be in charge of the Chicago plant and sales offices tributary thereto, and Mr. Carter, in general charge of production of all plants, with headquarters at the general office of the company, 910 S. Michigan Avenue, Chicago.

* * *

Kent Harrison has resigned as open hearth superintendent of the Lukens Steel Company, Coatesville, Pa. Mr. Harrison was formerly open hearth superintendent at the Donner Steel Company.

* * *

Mr. F. E. Flynn, formerly manager of the strip steel mill of the Weirton Steel Company at Weirton, W. Va., has been made assistant to the vice president of The Trumbull Steel Company, Warren, Ohio.

* * *

E. O. Shreve has been appointed manager of the newly created motor division of the industrial department of the General Electric Company. The new division will have general supervision of all policies, prices, etc., concerning all motors handled by the General Electric industrial department.

TRADE NOTES

The Bailey Meter Company announces the removal of its main office and works from 2015 East Forty-sixth Street to the new plant at 1050 Ivanhoe Road, where larger quarters and increased facilities are provided.

* * *

For the convenience of customers in the Pittsburgh district, the Rollway Bearing Company has opened a sales office at 614 Empire Building, Pittsburgh, Pa. Mr. Samuel Farrell, who has been affiliated with the Rollway Bearing Company, Inc., for a number of years with headquarters at Youngstown, Ohio, will be in charge of the above office.

* * *

The Semet-Solvay Engineering Corporation of New York, has been awarded a contract by the Management and Engineering Corporation of Chicago, for the construction of a purifier to be built on the plant of the St. Louis Coke and Iron Company, Granite City, Ill. Coke oven gas will be purified and piped to the mains of the Laclede Gas Light Company, St. Louis. Construction work will proceed at once.

The purifiers will be of the Steere type, built of steel and arc welded. There will be four round boxes, each 35 ft. in diameter and 12 ft. 6 in. high. Gas will be sent through at a normal rate of 270,000 cu. ft. an hour. The four boxes will contain 7700 sq. ft. of trays for holding oxide.

Manifold piping will be of the forward rotating type. Any of the boxes can be by-passed when desired. The manifold will be made of welded steel piping, 20 in. in diameter, and fitted with Steere Van Stone flanges and Steere gate vales.

This will be the second Steere purifier to be built in Granite City.

* * *

The Cohoes Rolling Mill Company, Cohoes, N. Y., is modernizing its skelp handling methods and is also contemplating the improvement of the skelp shearing tables of the 10-in. and 16-in. mills. U. A. Peters of Pittsburgh, Pa., is the consulting and designing engineer.

* * *

The Air Reduction Company, Inc., 342 Madison Avenue, New York, has acquired the assets and business of the Carolina Standard Gas Products Company, with an oxygen plant at Charlotte, N. C. The Air Reduction Sales Company now has the production and distribution facilities of 36 oxygen plants and 20 acetylene plants. These with warehouses give the company a total of 110 distributing points for oxy-acetylene gases, equipment and supplies.

* * *

On November 1, the Root Company of Bristol, Conn., manufacturers of automatic counters and hardware specialties, commemorated the 20th anniversary of the present corporation by the executives and foremen giving a banquet in honor of Mr. John T. Chidsey, president and general manager of the company. The Root Company is one of the oldest and foremost industries in the city of Bristol. It was in the early 60's that the business was started by Mr. Joel H. Root for the manufacture of hinges and specialties. At his death in 1885, he was succeeded by his son, the late C. J. Root, who continued manufacturing the same line and in 1891, started making the automatic counters for which the firm is now known all over the world. This firm was also one of the first to make hinges for the automobile industry, the continuous hood hinges being among its early products.

* * *

Hendrick Manufacturing Company, Carbondale, Pa., manufacturers of Mitco Interlocked Steel Grating, Mitco Shur-Site Stair Treads and Mitco Armorgrids, announces the opening of a Chicago District office, 223 Railway Exchange Building, Chicago, in charge of Mr. Lon Sloan. Mr. Sloan's extensive floor grating experience is available to those concerned with the selection of floor grating, stair treads and armorgrids for reinforcing concrete floors, platforms and driveways.

* * *

After January 1, 1928, the Pacific Coast Offices of The Cutler-Hammer Manufacturing Company, Milwaukee, Wis., manufacturers of electric motor control apparatus and allied lines, will be handled by their own Pacific Coast sales offices, at 970 Folsom Street, San Francisco; 229 Boyd Street, Los Angeles; 2203 First Avenue, South, Seattle.

The new sales district will be in charge of Mr. Fred H. Oberschmidt, a member of the Cutler-Hammer organization for over 15 years. Associated with Mr. Oberschmidt at the San Francisco headquarters office will be Mr. A. A. Tuffert and Mr. George P. Stone. Mr. Thomas N. Bristow will be in charge of the Seattle Office and Mr. Edward G. Nelson of the Los Angeles Office.

Special arrangements have been completed whereby production and shipment of special equipment for the Coast, built in the Cutler-Hammer factories at Milwaukee and New York, will be given preferred attention.

The establishment of these new sales offices is in line with the Cutler-Hammer policy of serving its customers direct wherever possible. It is the second new sales district to be opened within a short period—an office at Atlanta, Ga., having recently been established.

* * *

The Rust Engineering Company has recently received a contract for the installation of a Rust Refractory Recuperator to be installed in conjunction with a bar heating furnace at the plant of the Steel Company of Canada, Ltd., Hamilton, Ont. The furnace will be provided with a perforated arch through which highly preheated air from the recuperator will enter the combustion chamber, mixing with the coke oven gas, which will be used as fuel.

After passing through the furnace, the waste gases travel downwardly to the recuperator, which is situated beneath the furnace, and passes horizontally through the recuperator waste gas flues and thence to the stack.

The air for combustion enters the recuperator at the bottom and passes vertically upward through the air flues in refractory tile of Rust improved design. From the recuperator the preheated air is led upward to the perforated roof and enters the furnace chamber at this point.

Column construction used in building the recuperator with each tile being ground at the top and bottom to make a positive gravity seal.

THE STEEL PLANT BRICK MASON

Importance of Refractories

A goodly proportion of our country's clay product wealth lies in fire clay products, or fire clay refractories, as they are called. A generation ago the refractories industry of the United States produced $400,000 worth of product yearly. Today it is not far from $100,000,000.

Charles Catlett, who was chief of the Refractories Section of the War Industries Board, pays this fine tribute to refractories: "We are lost in admiration at the blowing of the Bessemer converter, at the volume of melted iron which runs from the base of a great blast furnace, or at the products which are formed in the intense heat of the electric arc, and we are apt to forget that these results are all evidences of a yielding to the influence of heat, and fail to give honor to the more wonderful, if less brilliant, material, whose ability to withstand the heat without yielding is necessary for the success of the operation.

"The country is dependent on refractory materials as primary products on which the production of others rest. They stand in the same relation to other products as the hidden foundation bears to the completed building."

—Laclede-Christy Bulletin.

Lewis a Director

J. E. Lewis, president of the Harbison-Walker Refractories Company, Pittsburgh, has been elected a director of the American Arch Company, New York. The American Arch Company holds a substantial stock interest in the Harbison-Walker Refractories Company.

Progress in Quality of Refractories

The general trend toward the improvement of refractories for specific uses is more pronounced, and not only have special products been featured, but the general run of common kinds has been bettered in various ways. More careful selection of raw materials and more accurate workmanship play a large part in the improvement, as well as certain improvements in brick plant equipment. In this campaign the laboratory has had an important part furnishing close technical control of the processes and a check of the finished product. The co-operation between the producer and consumer is on the whole closer and more friendly.

Down at the Weirton Steel Company, M. J. Rowland looks after all masonry work connected with the Blast and Open Hearth furnaces. He has two Blast furnaces and 10 Open Hearths to keep in repair.

American Refractories Institute Meeting

An exceptional large delegation of members of the American Refractories Institute attended the meeting held at the Hotel Chase, St. Louis, December 6-7. The program followed conformed to that published in the December issue of Blast Furnace and Steel Plant. One of the papers delivered, "The History of the Refractories Industry," by J. D. Ramsey, appears in full in this issue, and will be followed by others in future issues. On December 6 the meeting was held in conjunction with the American Institute of Chemical Engineers, of which Dr. E. R. Weidlein was elected president.

Laclede-Christy Moves

On December 19 the general offices of the Laclede-Christy Company moved from 1673 Railway Exchange Building to 1711 Ambassador Building. This large and beautiful building is one of the newest office structures in St. Louis.

Refractory Materials

Indeed, as in most things, the more knowledge that is acquired regarding the properties of refractory materials for high-temperature purposes — notably, of course, coke oven and gas practice, steel manufacture, etc.—the more it is borne in upon those concerned that we are only as yet at the beginning of things, so to speak. This was made abundantly manifest in the course of a paper and discussion upon the subject at the Conference of the Institution of Chemical Engineers in London in December. The author of the paper was Mr. A T. Green, of the Derbyshire Silica Firebrick Company, Ltd. The paper in question was purposely made of a general and introductory character for an audience supposed not to have an intimate knowledge of the problems of refractory materials, and because of that it constitutes an extremely useful review of the whole subject, serving to emphasize the work that has already been done and, still more, the directions in which work still remains to be done. At the same time, there was an important underlying idea in the paper—and that was the necessity for ascertaining the effect of actual industrial conditions upon the life and performance of refractory materials. This is a viewpoint to which not a great deal of reference has been made in the past. In other words, there is a need for an adequate definition of working conditions.

* * * * THE STEEL PLANT BRICK MASON * * * *

Admittedly, this phase of the subject is an exceedingly difficult one to discuss, because it is hardly likely that the working conditions in which refractory materials are used, even in the same industry, will be found to be the same in two cases. The very difference in the atmospheric conditions of the locality, not to mention inside the furnace or other plant, will have an effect, and this all leads to the conclusion that at present refractory materials do not lend themselves to very definite specification. Nevertheless, whilst those who have been most assiduous in refractory research during the past few years now appreciate this fact, they are also fully aware that this state of affairs must be overcome in the near future if the refractory material manufacturing industry is adequately to meet the increasing demands being made upon it. Certain efforts have been made at standardization, but in the light of subsequent experience it is becoming certain that these efforts were made at a time when insufficient knowledge was available, and therefore modifications must be made. One of the things which is puzzling many people is that whilst one or two particular refractory materials will show better qualities under the conditions of laboratory tests, in actual practice the one with the poorer qualities will stand up better, and from that point of view it is exceedingly difficult for the manufacturer to give anything in the nature of a guarantee of the life of the materials he supplies, even when he knows the working conditions. Yet the ordinary user wants to know, more than anything else, more or less the kind of service he is likely to get from a particular material rather than a mass of technical detail relating to porosity, spalling tests, specific gravity, and so on. It is some satisfaction that this fact is recognized in the industry, so that work along these lines is not likely to be neglected. All this naturally opens up an enormous prospect for research which must be applied not only to the finished product, but also to the nature of the raw materials, and, as already mentioned, also to the working conditions in which the finished product is used.

There still exists some controversy as to the properties of fireclay materials as distinct from silica, and the advocates of the two classes of material are likely to be putting forward their points of view for a long time. It will in all probability be found that there is a field for more than one type of refractory material according to the circumstances of use, and that, as in so many other directions, there is no one "best" material for all purposes. It is manifest that the correct selection of materials for specific duties is essential to industrial economy, and specifications must be regarded as of great value.

—Mechanical Engineering.

High Temperature Insulation*

Insulation is now being successfully applied to practically all types of equipment; including boilers, many types of furnaces; core, coke, baking and enamel drying ovens; oil stills and storage tanks; water gas sets and coal gas retorts; hot blast stoves and mains; soaking pits; brick, lime and cement kilns; glass-making equipment, etc.

One of the first applications of insulating brick was for the insulation of boiler settings. At the present time practically all water tube boilers have insulated settings. The air-cooled furnace walls used in powdered fuel boilers are insulated with insulating brick on the inside of the steel casing, next to the air space. Large stoker fired water tube boilers with solid furnace walls are insulated with insulating brick in back of 13½ or 18 in. of refractory.

A rather new application of insulation, but one which is now being employed satisfactorily by a number of plants, is the insulation of the blast furnace stack. A coarsely ground insulating powder is used, packed between the lining and the shell of the stack, above the mantle.

The insulation acts as a cushion between the refractory and shell, preventing the rivet shearing action encountered in many cases when dense materials are used. The effect of the insulation is to give a more uniform heat gradient through the lining with more uniform expansion and a lessened possibility of cracks forming. The shell is also protected against excessive temperatures.

A number of plants are insulating stacks because of the above advantages as well as to minimize the building-up action of the refractory lining due to condensation and chilling of zinc vapors or other impurities in the ore. Because a more uniform heat is maintained through the refractory, the vapors are carried through into the insulation where condensation takes place. Due to the great porosity of the insulating material it will absorb condensed vapors equal to 80 per cent of its volume.

The use of insulation is now recognized as an effective means of increasing the efficiency of the open-hearth process for making steel, and the regenerative systems of a large majority of the open-hearth installations of recent years have been thoroughly insulated.

In a comprehensive paper by Waldemar Dryssen, formerly open-hearth expert of the United States Steel Corporation, he shows that the heat radiation loss from uninsulated air and gas checkers and flues, amounts to 13.2 per cent of the total heat in the fuel, and that by insulating, this loss can be reduced 50 per cent or to 6.6 per cent.

With the increasing use of waste heat boilers for recovering the surplus heat in waste gas, the minimizing of radiation losses and the preventing of air infiltration become increasingly important. It has been proved in practice that a much larger amount of steam is produced in the waste heat boilers if the checker chambers are effectively heat insulated and if care is taken to seal all leaks which allow air to be mixed with the waste gases before entering the waste heat boilers.

The open-hearth furnace itself has never been insulated due to the extremely high temperatures employed. Although there are insulating materials available that would stand the temperature satisfactorily, the life of the refractories, particularly in the roof, would undoubtedly be shortened somewhat. The short life of the roof is one of the principal problems of the open-hearth superintendent, and with the refractories at present available for this purpose it is considered economical in this case to sacrifice a large part of the heat by radiation and secure the longest possible life out of the refractory.

---

*From Bulletin compiled by Celite Products Company, Los Angeles, Cal.

The efficiency of soaking pits can be raised considerably by the use of insulation. Heat balances on some uninsulated pits of the United States Steel Corporation show an efficiency, based on heat actually absorbed by the steel, of 8.6 per cent, the radiation loss being over 25 per cent. The radiation loss can be cut down about 70 per cent by insulation.

Another important application of insulation in the steel industry is for the lining of producer gas mains. As the gas entering the mains is in most cases at a temperature of from 1400 to 1600 deg. F., there is opportunity for excessive heat losses in long mains unless insulation is used. The saving of sensible heat effected by insulation depends, of course, on the size of the installation, and on the size and length of the main. Assuming, however, an installation gasifying 75 tons of coal per day with the average size main the saving due to the insulation amounts to about 1300 tons of coal per year, which would be equivalent to a return on the investment of well over 100 per cent per year.

While fuel saving is the principal advantage of insulation and the one most readily convertible into dollars and cents, there are other attendant advantages which in many classes of work are considered to be at least as important as the saving in fuel. First among these is the improvement in the quality of heat-treated products which is brought about by the more uniform and more accurate temperature control which is possible with insulated equipment. It is therefore unnecessary to overheat certain portions of the equipment in order to bring the remote parts to the required temperature.

Uniform temperatures are important in all cases but especially so in glass annealing; steel treating; brick, porcelain and pottery manufacture; oil refining; lime burning and bread baking. For instance, in the burning of brick in periodic kilns it is often impossible with uninsulated equipment to attain the proper temperature in the kiln bottoms with the result that a considerable portion of the ware is improperly burned and saleable only as second quality product. By thorough insulation much more uniform heat distribution is possible.

An Account of the Softening of Refractories by Heat

The object of this bulletin is to discuss in an elementary manner the subject of melting of refractories by heat. The softening of a refractory material by heat is not as simple a process as one might expect. The changes that result from heat treatment are numerous, and are complicated in their nature, so they will be discussed only in a general way at this time.

Mention is often made of the "melting point" of a refractory. This term, however, if used in its correct sense, can seldom be applied to refractories, as will be pointed out.

Ice, for example, remains solid and does not show any signs of melting unless sufficient heat is added to it to raise its temperature above 32 deg. F., and for this reason the melting point of ice is 32 deg. F. (0 deg. C.). Ice, however, is a pure chemical compound (water) comprised of two elements, namely, hydrogen and oxygen, which are always present in the same proportions. Such pure compounds follow the laws of science and always behave in the same manner when treated in a definite way. For this reason all pure chemical compounds in a solid form that can be melted by heat will melt at a definite temperature. This melting point, or temperature, will always be the same, regardless of the rate at which they may be heated. It does not make any difference how long the material is heated at any temperature below the melting point, because it will only melt at one temperature. This reasoning does not apply to refractories[1] since they are mixtures of a number of chemical compounds. Each constituent or compound in refractories has a true melting point, but when these are combined and heated their individual melting points are not apparent.

Clays, for example, are comprised of pure clay matter and varying amounts of a large number of impurities, which are of an exceedingly small particle size. Each microscopic grain by itself melts at a definite temperature, but this temperature is not the same for each constituent that is present. The feldspar, for example, may melt as low as 2300 deg. F., while the silica would require 3100 deg. F. for melting to occur. Upon gradually heating a clay containing such a variety of materials, it would be expected that various changes would occur as the temperature is increased, due to the melting of the constituents at different temperatures. This is what occurs in all clays and largely accounts for the changes that take place upon firing, such as shrinkage, increased mechanical strength and the changes in color.

The particles in the clay that have the lowest melting temperature become liquid at a temperature which does not affect particles of a higher melting point. The clay when heated to these relatively low temperatures has in it, therefore, a small quantity of liquid material, the remainder being solid. This liquid tends to surround the solid and more refractory grains and exerts a force[2] which draws the grains closer together. Firing shrinkage can generally be attributed to this action of the low melting constituents. Such materials in the clay are termed "fluxes," because they tend to lower the refractoriness of it. While in the molten condition, the fluxes attack the more refractory grains, taking them also into solution and form what is termed a glass. These degrading effects of some of the fluxes take place at a low temperature, but increase in activity as the temperature is increased. Each type of flux requires a certain temperature to begin its action and naturally those that melt at a low temperature are the most objectionable. The glass formed by the flux varies in quantity and in refractoriness, depending upon a number of conditions which cannot be taken up here.

---

*Abstracted from Bulletin No. 17, issued by the American Refractories Institute.

[1] Relatively pure chemical compounds are occasionally used as refractories, for example, some electric furnace products.

[2] By surface tension.

SAFETY FIRST IN THE STEEL PLANT

Cambria Has No Lost Time Accident in November

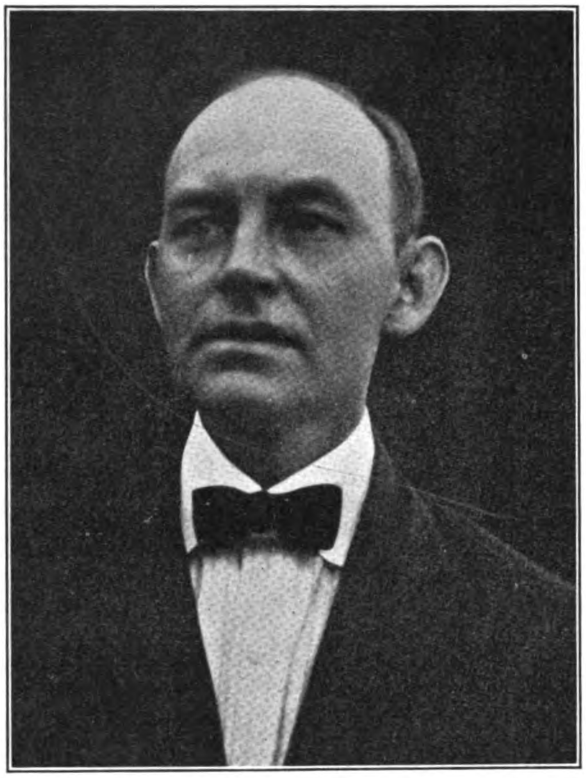
Seven departments in the Cambria works at Johnstown, Pa., of the Bethlehem Steel Corporation, operated throughout November without a lost-time accident, and the Gautier department was awarded the safety trophy because of the larger number of men employed there. Marcus A. Dow, New York, past president of the National Safety Council, gave the audience assembled upon that occasion an interesting talk on "Remember the Little Things."

Charles M. Schwab Emphasizes "Human Engineering"

If there is one outstanding slogan which serves as a common motto for American industry today, that slogan is expressed in the phrase "Safety First." The fact that this has become the outstanding slogan is an expression of the supreme management of American industry, namely, that the conduct of industry involves not merely the efficient direction of machines, but primarily the guidance, the protection and the promotion of the welfare of human beings.

Human engineering—that's the real study of the great engineer of today.

Amazing progress has been made in bringing about efficient and economical production. The modern scientist has enabled us to manipulate machines through his penetration for us into the secrets of chemistry and physics. But the transcendent machine is the human being, the man with feelings, with sensibilities, with hopes and fears and responsibilities. It is the human being of whom we are thinking more than ever today, and the business man is a poor manager whose primary thought is not to bring about a fuller life and a finer existence for the human beings with whom he comes in contact.



Edgar G. Quesnel holds the position of Safety Engineer at the Commonwealth Steel Company, Granite City, besides being vice-chairman of the metals section of the National Safety Council.

Eugene G. Grace Offers Gold Awards

Eugene G. Grace, president of the Bethlehem Steel Corporation, announced on January 2 a series of gold awards for progress during 1928 in eliminating human waste caused by preventable accidents. These awards will be made quarterly under a new plan to be inaugurated throughout the entire Bethlehem organization. This plan will include all the corporation's subsidiaries and will include more than 68,000 employes in the steel plants, mines, quarries, shipyards and other operating units.

The new plan takes the form of an accident prevention contest to further the efforts of Bethlehem and its employes to eliminate accidents and to stimulate greater interest in this work during the current year. Under the plan as announced, the Bethlehem organization will be divided into 11 groups. The plan provides that the group making the greatest percentage of reduction in time lost due to accidents during each three months' period in the year 1928 will be awarded a grand prize of $1,000 in gold. To the groups making the second and third best showing will be awarded prizes amounting to $500 and $250, respectively. To the group making the greatest reduction in the time lost due to accidents for the entire year 1928 will be awarded a permanent trophy.

The cash awards will be disbursed by the management in charge of the winning groups in such a manner as will best recognize individual efforts of employes in accident prevention work. One of the features of the plan, however, in this respect is that the disposition of the awards will be determined jointly for each group by the management and representatives of the employes. This is in line with the Bethlehem policy of handling all matters of industrial relations on a joint co-operative basis.

Notes from the Steel Plants

Records of the Wheeling Steel Corporation, at Wheeling, W. Va., show that their 18 plants with a total of 11,532 full time employes went through the month of October, 1927, with the lowest number of lost time accidents in the history of the corporation, namely 39 cases. Also they did not have a single permanent partial disability injury during that period.

* * *

The Midvale Company reports a good record, the figures of which are not yet reported. They have a system of safety pledge cards by which employes voluntarily sign a safety pledge. Their safety talks stress particularly two rules: "Do not trespass on railroad tracks," and "Do not stand or walk under crane loads."